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VERTICAL MOVEMENTS OF *ANEIDES AENEUS* AND *PLETHODON*  
*GLUTINOSUS* (CAUDATA, PLETHODONTIDAE)<sup>1</sup>

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ABSTRACT

Direction of movement of *Aneides aeneus* and *Plethodon glutinosus* released on 90° and 45° substrates was determined. Both species generally move upward when released on or at the bottom of 90° surfaces. *Aneides aeneus* moves upward or downward about equally on 45° slopes, while *Plethodon glutinosus* usually moves up-slope. When released at the top of a 90° surface, *A. aeneus* climbs down, and *P. glutinosus* jumps without attempting to climb downward. Under no test conditions does *P. glutinosus* try to climb down 90° surfaces.

INTRODUCTION

The plethodontid salamanders, *Aneides aeneus* and *Plethodon glutinosus*, occur together in sandstone cliffs in Tishomingo County, extreme northeastern Mississippi, where *A. aeneus* occupies higher crevices in the vertical cliff habitat. This stratification may be due in part to the greater physiological capabilities of *A. aeneus* to live in relatively dry crevices (Gordon 1952), combined with anatomical specializations allowing it to climb vertical walls with greater ease than does *P. glutinosus* (Cliburn and Porter 1986), and to enter smaller and higher crevices. Directional responses of these salamanders when confronted with a vertical substrate also may be factors involved in the establishment and maintenance of a vertical distribution in cliffs.

Orientation studies of anurans (Ferguson 1966; Ferguson and Landreth 1966; Ferguson et al. 1965; Ferguson et al. 1967; Landreth and Ferguson 1966; Taylor and Ferguson 1969) and salamanders (Alder and Taylor 1973; Cliburn and Pihkala 1986; Ferguson and Landreth 1967; Phillips and Adler 1977; Pihkala and Cliburn 1986; Shoop 1965; Twitty et al. 1964) have dealt with movements of amphibians on a horizontal plane. This report deals with movements of the salamanders *Aneides aeneus* and *Plethodon glutinosus* on vertical or inclined substrates. The study was

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conducted to determine in which direction the salamanders orient, and if any significant differences exist in such tendencies.

A salamander may approach a cliff in three possible ways after movement across the forest floor. It may approach the base of the cliff, after which upward movement over a vertical substrate would allow the animal to locate and occupy a crevice, and an individual with a stronger drive to climb upward might eventually occupy the highest crevice. However, the cliff may also be approached from above, and a salamander which climbed downward could locate and occupy the highest crevice. At places, the topography of the forest floor around these cliffs may provide a third approach to the highest crevice. The forest floor may slope upward parallel to the cliff face at an angle of approximately  $45^\circ$ . By moving up this inclined slope, a salamander may enter a high horizontal crevice, provided the crevice intercepts the slope, and occupy a position several feet above the base of the cliff. Tests were performed to determine how the two species responded to a vertical substrate and to a substrate inclined at  $45^\circ$ .

*Field Studies.*--Testing was done on a section of sandstone cliff at least 100 m from the points of capture of the subjects, and it is improbable that any of them were familiar with the test area, since *A. aeneus* (Gordon 1961) and *P. glutinosus* each has a small home range and is fairly sedentary (personal observation). The cliff was nearly vertical and uniform in topography; no crevices or other cover were visible to the salamander from the release point 150 cm above the cliff base. However, to those animals released 15 cm above the cliff base, cover in the form of leaf litter was visible, vertically beneath the salamander or horizontally to one side due to the slope of the floor at the bottom of the cliff.

Tests were done at night and during the day to determine possible differences in orientation. Two release points were used, one at 150 cm above the base of the cliff and one at 15 cm, to determine if proximity to the ground and cover would influence direction of movement.

Each subject was released on the face of the cliff with its head up toward the top of the cliff, and the final direction of movement was recorded after each animal had moved radially 100 cm from the release point, or when it had reached the cliff base. The same test was repeated with the head downward. Movements above the horizontal were recorded in positive degrees:  $+30^\circ$ ,  $+60^\circ$ , or  $+90^\circ$ . Movements below the horizontal were recorded in negative degrees:  $-30^\circ$ ,  $-60^\circ$ , or  $-90^\circ$ . Horizontal movements were recorded as  $0^\circ$ . One hundred fifty six tests were done with *Aneides aeneus*; 23 attempts were made with *Plethodon glutinosus*, but these were not continued as all subjects either fell or jumped from the cliff face upon release. Salamanders were moistened frequently and were handled as little as possible to reduce trauma and produce a more normal response.

*Laboratory Studies.*--Laboratory tests for stratification and climbing abilities had indicated that *P. glutinosus* may climb a vertical surface, particularly in the head up position (Baltar 1983). In the field

tests of orientation, all *P. glutinosus* tested either fell or jumped instantly upon being placed on the cliff. Laboratory procedures with portable apparatus were subsequently followed to reduce falling or jumping and allow the salamander to make a more deliberate response. A vertical plane 30 cm wide x 200 cm high was constructed of plywood to which sand had been cemented to simulate a natural sandstone surface. A step, 25 mm wide, was constructed across the midline of this apparatus, so that a salamander placed on the step would have the options of remaining on the ledge, climbing up, or going down over the edge of the step onto the vertical plane below (Test 1-A).

In a modification of this test, the above described apparatus was fitted with an inclined plane which extended downward from the step at a 45° angle. This slope was 15 cm wide and of the same sand texture as the other surfaces. Animals placed on the step now had the added option of descending along the incline (Test 1-B).

To determine orientation of these salamanders when confronted with an incline in the absence of either a horizontal or vertical surface, tests were also done in which subjects were released at the midline of the incline, with options of going upward or downward (Test 2).

Because a salamander in nature might approach a cliff from above, additional tests were performed. A boxlike apparatus was constructed of fiberboard, and sand was cemented to the outer surfaces to simulate the texture of the sandstone cliff. The horizontal upper surface was 60 x 60 cm, and the vertical walls were 60 cm high. This apparatus was placed within a large cardboard box (72 x 100 x 150 cm high) with a removable lid to serve as a screen which hid the observer from the test animal. Testing was done in semi-darkness, with observations being made through small apertures.

A test subject was placed at the center of the horizontal surface, covered by an opaque plastic Petri dish which was lifted away after two minutes by a string. The salamander was then free to remain on the upper surface or to descend to the floor (Test 3).

## RESULTS AND DISCUSSION

*Field Studies.*--Results of field tests in which *A. aeneus* were released on the cliff face are given in Table 1. They indicate that *A. aeneus* generally climbs upward, regardless of light conditions (day or night), but when released near cover, may move downward or horizontally toward cover. When the subject was placed head down, the range of directions was much more variable and the mean direction was generally lower. Several comparisons were made to reveal any significant differences in mean direction due to light conditions, with none being shown (see Table 2).

Because significant differences were not indicated for the pairings indicated above, data for all night tests were combined for comparison with the combined data for all day tests, with no significant difference indicated (Table 2).

Table 1. *Aneides aeneus*. Orientation Field Studies. Responses of salamanders released on a vertical cliff. High indicates release 150 cm from cliff base; low = 15 cm from base. + = upward, - = downward, 0 = horizontal directions.

Test conditions	Number of tests	Direction, range, degrees	Direction mean, degrees	Standard deviation	Standard error of mean
Head up, high, night	15	+60 - +90	+88	7.75	2.07
Head up, high, day	33	0 - +90	+75.46	26.11	4.55
Head down, high, night	15	-90 - +90	+20	74.93	20.03
Head down, high, day	27	-90 - +90	+13.33	61.61	12.08
Head up, low, night	15	0 - +90	+72	31.67	8.46
Head up, low, day	16	0 - +90	+52.63	40.47	10.48
Head down, low, night	15	-90 - 0	-36	39.61	10.59
Head down, low, day	20	-90 - +90	-10.50	61.00	13.99
Night, combined	60	-90 - +90	+36	66.01	8.52
Day, combined	96	-90 - +90	+35.94	58.74	6.00
Head up, combined	79	0 - +90	+72.15	30.58	3.44
Head down, combined	77	-90 - +90	- 1.17	63.07	7.19

To determine if head position of the salamander when released had any effect on direction of movement, combined data for the down position were compared with combined data for the up position, with a significant difference indicated. A significant difference also was shown between responses of all subjects released high on the cliff (no cover visible) and those released low (cover visible) (Table 2).

*Laboratory Studies.*-- Test 1-A (Table 3). In these tests, *P. glutinosus* always fell when attempting any maneuver other than slow vertical movements. Subjects which jumped down from the ledge landed at



# Plethodontid orientation

Table 2. *Aneides aeneus*. Orientation Field Studies. Results of analysis of variance for significance of the difference of the means.

Test conditions	F value, significance	Test conditions
Head up, high, night	F = 3.31, P > 0.05	Head up, high, day
Head down, high, night	F = 0.097, P > 0.05	Head down, high, day
Head up, low, night	F = 2.657, P > 0.05	Head up, low, day
Head down, low, night	F = 1.988, P > 0.05	Head down, low, day
Night, combined	F = 0.319, P > 0.05	Day, combined
Head up, combined	F = 88.78, P < 0.0005	Head down, combined
Low, combined	F = 13.25, P < 0.001	High, combined

least 54 cm from the base of the vertical plane. There was a significant deviation from the prediction that salamanders would respond equally well to all the options. *Plethodon glutinosus* showed a pronounced tendency to move upward on a vertical wall, or to *jump* downward if this option was available, and upward movement was not possible.

*Aneides aeneus* showed a strong tendency to move upward on the vertical wall. Tests of the hypothesis that *A. aeneus* and *P. glutinosus* would respond alike to the three options showed that *A. aeneus* has a much greater tendency than *P. glutinosus* to climb both upward and downward, and *P. glutinosus* has a greater tendency to jump.

Test 1-B (Table 4). Of the *P. glutinosus* which moved upward, 58% slipped but eventually regained their footing at the ledge and then climbed upward successfully. *P. glutinosus* showed a definite tendency to move up on a vertical wall, but if an inclined surface was available, it "preferred" to climb downward on this surface rather than jump or climb vertically downward.

Test 2 (Table 5). With *A. aeneus*, a significant deviation from the prediction of equal responses was shown, indicating that this salamander climbs either up or down a slope about equally, but does not usually jump. The behavior of *P. glutinosus* also departed considerably from the predicted, and indicated that *P. glutinosus* tends to move upward on inclines where possible, and rarely moves downward. When it is possible to climb up rather than jump, this salamander climbs.

Table 3. Results of Chi-square tests of the hypotheses that *Aneides aeneus* and *Plethodon glutinosus* would have no "preferences" among optional responses, and that they would respond alike.

Response	<i>Aneides aeneus</i>		$\chi^2$ , confidence level	<i>Plethodon glutinosus</i>	
	No.	%		No.	%
Climb up total	20	87	21.85, $P < 0.001$	13	50
(Climb up attempts)	20	87	29.59, $P < 0.001$	18	69
(Slip or fall)	0	0	8.95, $P < 0.02$	12	67
Climb down	1	4	12.6, $P < 0.001$	1	4
Jump	2	9	5.5, $P < 0.02$	12	46
No. of tests	23			26	
$\chi^2$	29.81			19.11	
Confidence level	$P < 0.001$			$P < 0.001$	

Table 4. Results of Chi-square tests of hypothesis that *Plethodon glutinosus* would respond equally to all options.

	<i>Plethodon glutinosus</i>	
Response	No.	%
Climb up 90°	12	60
Climb down 90°	0	0
Climb down 45°	8	40
Jump	0	0
No. of tests	20	
$\chi^2$	21.6	
Confidence level	$P < 0.001$	

Comparisons of responses of *A. aeneus* and *P. glutinosus* to each other indicated significant differences in the up and down options, but not in the jump option. *P. glutinosus* moved upward at a much higher rate than did *A. aeneus*. *A. aeneus* used the down option more commonly

than did *P. glutinosus*, although there was no significant difference in their use of the jump option.

Table 5. Results of Chi-square test of hypotheses that *Aneides aeneus* and *Plethodon glutinosus* would have no "preferences" among optional responses, and that they would respond alike.

Response	<i>Aneides aeneus</i>		$\chi^2$ , confidence level	<i>Plethodon glutinosus</i>	
	No.	%		No.	%
Climb up 45°	8	44	11.4, $P < 0.001$	10	91
Climb down 45°	9	50	7.87, $P < 0.05$	1	9
Jump	1	6	3.47, $P > 0.05$	0	0
No. of tests	18			11	
$\chi^2$	6.34			16.53	
Confidence level	$P < 0.05$			$P < 0.001$	

Test 3 (Table 6). *A. aeneus* climbs vertically downward in preference to the other possibilities. No. *P. glutinosus* attempted to climb down the wall. Those which jumped over the edge usually did so with little hesitation. (In the field, this salamander has been seen to jump from a height of 200 cm.) *P. glutinosus* apparently descends cliffs by jumping rather than climbing. There are significant differences in responses of *A. aeneus* and *P. glutinosus* when a vertical wall is approached from above across a horizontal surface. *A. aeneus* is more likely to climb downward, and *P. glutinosus* is more likely to jump, or to turn away from the edge, suggesting that *P. glutinosus* may sometimes avoid a cliff when it is approached from above but *A. aeneus* does not.

A summary of all field and laboratory orientation tests indicated that both *A. aeneus* and *P. glutinosus* tend to climb upward if confronted with a vertical surface to which it is possible to cling. Approximately 90% of *A. aeneus* moved upward, as did approximately 50% of *P. glutinosus*; 46% of *P. glutinosus* jumped down, although they did so only when it was not possible to move upward. When confronted with a 45° inclined surface, 44% of *A. aeneus* moved upward along the slope, as did 91% of the *P. glutinosus*. Fifty percent of *A. aeneus* went down the slope, while only 9% of *P. glutinosus* moved downward. The indifferent reaction of *A. aeneus* to the 45° slope may indicate that such a cue evokes no particular directional response in this species. When a diagonal surface provided an alternate downward route and vertical upward and downward routes were also available, 60% of *P. glutinosus* moved upward, and 40% moved downward along the slope.

Table 6. Results of Chi-square test of hypotheses that *Aneides aeneus* and *Plethodon glutinosus* would have no "preferences" among optional responses, and that they would respond alike.

	<i>Aneides aeneus</i>		X <sup>2</sup> , confidence level	<i>Plethodon glutinosus</i>	
Response	No.	%		No.	%
Climb down 90°	28	97	43.8, P < 0.001	0	0
Jump	1	3	31.0, P < 0.001	24	86
Remain (turn away)	0	0	12.7, P < 0.001	4	14
No. of tests	29			28	
X <sup>2</sup>	52.21			35.44	
Confidence level	P < 0.001			P < 0.001	

The different responses in the slope tests may indicate a stronger upward response in *P. glutinosus* than in *A. aeneus*. This may be related to the difficulties which *P. glutinosus* has when climbing down a more nearly vertical wall, and the relative ease with which *A. aeneus* climbs downward (Cliburn and Porter 1986). *Plethodon glutinosus* has maintained a tendency to move upward, since downward movements usually result in falling.

To conclude, both *A. aeneus* and *P. glutinosus* orient upward on vertical walls, but *A. aeneus* climbs downward on inclines with about the same frequency as it moves upward. *Plethodon glutinosus* also climbs downward on inclines, but at a lower frequency than that for upward movements. An incline which intersected the vertical cliff wall could thus provide both species access to horizontal crevices from either above or below the cliff. If upward movement is thwarted, and no slope is available, *A. aeneus* climbs down, but *P. glutinosus* jumps downward. A result of this behavior is that *A. aeneus* may move onto a vertical cliff (without a sloping approach) from below or from above, but *P. glutinosus* may move onto it only from below, since jumping takes it to the base level of the cliff. Once on the cliff face, *A. aeneus* orients upward, occupying higher levels.

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# A TYPE OF PARTIAL FRACTION DECOMPOSITION<sup>1</sup>

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The purpose of this brief article is to develop an efficient algorithm for resolving an expression of the form

$$\frac{(a_1x+b_1)(a_2x+b_2)\dots(a_kx+b_k)}{(x-a)^n} \quad \text{for } k < n$$

into partial fractions. The technique developed is readily adaptable to computer methods. Further, the proof of the theorem stated below, though a bit cumbersome, offers an example of an involved induction. The proof of the theorem is deferred until a discussion of the technique and an example of its application have been provided.

**THEOREM.** Suppose  $F(x) = \frac{(a_1x+b_1)\dots(a_kx+b_k)}{(x-a)^n}$  for  $k < n$ ,  $a \neq \frac{a_i}{b_i}$

for  $i=1,2,\dots,k$ , and each of  $a, a_i, b_i$ , for  $i=1,2,\dots,k$  is an element of the set  $\mathbb{C}$  of complex numbers. Further suppose that  $c_m$  is the sum of all products of the form  $q_1q_2\dots q_k$  where  $q_i = a_i$  or  $q_i = b_i$  and there are  $m$  of the  $a_i$ 's and there are  $k-m$  of the  $b_i$ 's.

$$(1) \quad \text{Then } F(x) = \frac{1}{(x-a)^n} \sum_{p=0}^k c_p \sum_{j=0}^p \binom{p}{j} a^j (x-a)^{p-j}$$

The theorem provides a decomposition of the given expression once the values  $c_k, c_{k-1}, \dots, c_0$  are obtained. Note that  $c_m$  is the sum of all combinations of  $m$  of the  $a_i$ 's and  $k-m$  of the  $b_i$ 's and that therefore each  $c_m$  can easily be evaluated in a systematic way. The theorem also

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<sup>1</sup>Manuscript received 10 July 1986; accepted 14 August 1986.

enables us to examine the structure of such a partial fraction decomposition.

The following is an illustration of these remarks. Suppose we wish to resolve

$$\frac{(a_1x+b_1)(a_2x+b_2)(a_3x+b_3)(a_4x+b_4)}{(x-a)^n} \quad \text{for } N > 4$$

The values  $c_m$  are

$$c_4 = a_1a_2a_3a_4$$

$$c_3 = a_1a_2a_3b_4 + a_1a_2b_3a_4 + a_1b_2a_3a_4 + b_1a_2a_3a_4$$

$$c_2 = a_1a_2b_3b_4 + a_1a_3b_2b_4 + a_1a_4b_2b_3 \\ + a_2a_3b_1b_4 + a_2a_4b_1b_3 + a_3a_4b_1b_2$$

$$c_1 = a_1b_2b_3b_4 + b_1a_2b_3b_4 + b_1b_2a_3b_4 + b_1b_2b_3a_4$$

$$c_0 = b_1b_2b_3b_4.$$

The double sum can be evaluated by the following table.

n-4	1				
n-3	4a	1			
n-2	6a <sup>2</sup>	3a	1		
n-1	4a <sup>3</sup>	3a <sup>2</sup>	2a	1	
n	1a <sup>4</sup>	1a <sup>3</sup>	1a <sup>2</sup>	1a	1
	c <sub>4</sub>	c <sub>3</sub>	c <sub>2</sub>	c <sub>1</sub>	c <sub>0</sub>

which is read as

$$F(x) = (x-a)^{-(n-4)} c_4 + (x-a)^{-(n-3)} [4ac_4 + c_3] \\ + (x-a)^{-(n-2)} [6a^2c_4 + 3ac_3 + c_2] + (x-a)^{-(n-1)} [4a^3c_4 + \\ 3a^2c_3 + 2ac_2 + c_1] + (x-a)^{-n} [a^4c_4 + a^3c_3 + \\ a^2c_2 + ac_1 + c_0].$$



Note that a coefficient in the  $m$ 'th column corresponding to  $c_m$  is the product of the binomial coefficient of  $(x-a)^m$  and the corresponding power of  $a$  associated with it. Such a table easily lends itself to an expression involving many products of linear factors.

EXAMPLE. Decompose the expression 
$$\frac{(x-2)(2x+3)(3x-1)}{(x-4)^5}$$

$$\begin{aligned} c_3 &= 1 \cdot 2 \cdot 3 &= 6 & (a_1 a_2 a_3) \\ c_2 &= 1 \cdot 2 \cdot (-1) + 1 \cdot 3 \cdot 3 - 2 \cdot 2 \cdot 3 &= -5 & (a_1 a_2 b_3 + a_1 b_2 a_3 + b_1 a_2 a_3) \\ c_1 &= 1 \cdot 3 \cdot (-1) - 2 \cdot 2 \cdot (-1) - 2 \cdot 3 \cdot 3 &= -17 & (a_1 b_2 b_3 + b_1 a_2 b_3 + b_1 b_2 a_3) \\ c_0 &= -2 \cdot 3 \cdot (-1) &= 6 & (b_1 b_2 b_3) \end{aligned}$$

Thus with  $a=4$  and  $n=5$  we have

n-3	1				$\Rightarrow$	2	1					
n-2	3a	1				3	12	1				
n-1	3a <sup>2</sup>	2a	1				4	48	8	1		
n	1a <sup>3</sup>	1a <sup>2</sup>	1a	1				5	64	16	4	1
	$c_3$	$c_2$	$c_1$	$c_0$					6	-5	-17	6

$$\begin{aligned} \frac{(x-2)(2x+3)(3x-1)}{(x-4)^5} &= \frac{6}{(x-4)^2} + \frac{72-5}{(x-4)^3} + \frac{288-40-17}{(x-4)^4} \\ &\quad + \frac{384-80-68+6}{(x-4)^5} \\ &= \frac{6}{(x-4)^2} + \frac{67}{(x-4)^3} + \frac{231}{(x-4)^4} + \frac{242}{(x-4)^5} \end{aligned}$$

We now prove the theorem.

PROOF: Expanding the sums in (1), rearranging and replacing  $p$  with  $k - p + j$  transforms expression (1) into

$$(2) \quad \frac{1}{(x-a)^{n-k}} \sum_{p=0}^k \binom{-p}{(x-a)} \sum_{j=0}^p \binom{k-p+j}{j} a^j c_{k-p+j}.$$

We proceed by induction on  $k$ . Clearly, for  $k=1$  we have

$$\begin{aligned} \frac{a_1 x + b_1}{(x-a)^n} &= \frac{b_1}{(x-a)^n} + \frac{a_1}{(x-a)^n} \left[ (x-a) + a \right] \\ &= \frac{1}{(x-a)^n} \left\{ c_0 + c_1 \left[ (x-a) + a \right] \right\} \\ &= \frac{1}{(x-a)^n} \sum_{p=0}^k \binom{-p}{(x-a)} \sum_{j=0}^p \binom{1-p+j}{j} a^j c_{1-p+j}. \end{aligned}$$

$$\text{Letting } G_k(x) = \frac{(a_1 x + b_1) \dots (a_k x + b_k)}{(x-a)^n},$$

then  $G_{k+1}(x) = G_k(x) a_{k+1}(x-a) + G_k(x) [a_{k+1}a + b_{k+1}]$ , for  $k+1 < n$ .

Applying our inductive hypothesis we have

$$\begin{aligned} &\frac{1}{(x-a)^{n-k-1}} \sum_{p=0}^k \binom{-p}{(x-a)} \sum_{j=0}^p \binom{k-p+j}{j} a^j a_{k+1} c_{k-p+j} \\ &+ \frac{1}{(x-a)^{n-k}} \sum_{p=0}^k \binom{-p}{(x-a)} \sum_{j=0}^p \binom{k-p+j}{j} a^j (a a_{k+1} + b_{k+1}) c_{k-p+j} \end{aligned}$$

Collecting terms in powers of  $x-a$  the above yields

$$\begin{aligned}
 (3) \quad & \frac{1}{(x-a)^{n-k-1}} \binom{k}{0} a_{k+1} c_k \\
 & + \frac{1}{(x-a)^{n-k}} \left[ \left\{ \binom{k-1}{0} a_{k+1} c_{k-1} + \binom{k}{0} b_{k+1} c_k \right\} \right. \\
 & \quad \left. + \left\{ \binom{k}{0} + \binom{k}{1} \right\} a a_{k+1} c_k \right] \\
 & + \frac{1}{(x-a)^{n-k+1}} \left[ \left\{ \binom{k-2}{0} a_{k+1} c_{k-2} + \binom{k-1}{0} b_{k+1} c_{k-1} \right\} \right. \\
 & \quad + \left\{ \binom{k-1}{0} + \binom{k-1}{1} \right\} a a_{k+1} c_{k-1} + \binom{k}{1} a b_{k+1} c_k \\
 & \quad \left. + \left\{ \binom{k}{1} + \binom{k}{2} \right\} a^2 a_{k+1} c_k \right] \\
 & + \dots \\
 & + \frac{1}{(x-a)^n} \left[ \binom{0}{0} \binom{0}{0} (a a_{k+1} + b_{k+1}) c_0 + \dots + \binom{k}{k} a^k (a a_{k+1} + b_{k+1}) c_k \right].
 \end{aligned}$$

The  $C_m$ 's come from the following calculations:

$$\begin{aligned}
 & \binom{k}{0} a_{k+1} c_k = \binom{k+1}{0} c_{k+1}; \\
 & \binom{k-1}{0} a_{k+1} c_{k-1} + \binom{k}{0} b_{k+1} c_k \\
 & = a_{k+1} (a_1 a_2 \dots a_{k-1} b_k + a_1 a_2 \dots b_{k-1} a_k + \dots + b_1 a_2 \dots a_k) + b_{k+1} a_1 a_2 \dots a_k \\
 & = a_1 a_2 \dots a_k b_{k+1} + a_1 a_2 \dots b_k a_{k+1} + \dots + b_1 a_2 \dots a_k a_{k+1} = \binom{k}{0} c_k ;
 \end{aligned}$$

$$\left\{ \binom{k}{0} + \binom{k}{1} \right\} a a_{k+1} c_k = \binom{k+1}{1} a c_{k+1} ;$$

$$\binom{k-2}{0} a_{k+1} c_{k-2} + \binom{k-1}{0} b_{k+1} c_{k-1} = \binom{k-1}{0} c_{k-1} ;$$

$$\left\{ \binom{k-1}{0} + \binom{k-1}{1} \right\} a a_{k+1} c_{k-1} + \binom{k}{1} a b_{k+1} c_k$$

$$= \binom{k}{1} a a_{k+1} c_{k-1} + \binom{k}{1} a b_{k+1} c_k = \binom{k}{1} a c_k ;$$

$$\left\{ \binom{k}{1} + \binom{k}{2} \right\} a^2 a_{k+1} c_k = \binom{k+1}{2} a^2 c_{k+1} ; \dots ; \text{ and}$$

$$\binom{0}{0} (a a_{k+1} + b_{k+1}) c_0 + \dots + \binom{k}{k} (a a_{k+1} + b_{k+1}) c_k$$

$$= b_{k+1} c_0 + \left( a a_{k+1} c_0 + a b_{k+1} c_1 \right) + \dots + a^{k+1} c_{k+1}$$

$$= c_0 + a c_1 + \dots + a^{k+1} c_{k+1}$$

Collecting terms in expression (3) yields

$$\frac{1}{(x-a)^{n-k-1}} \binom{k+1}{0} c_{k+1} + \frac{1}{(x-a)^{n-k}} \left[ \binom{k}{0} c_k + \binom{k+1}{1} a c_{k+1} \right]$$

$$+ \frac{1}{(x-a)^{n-k+1}} \left[ \binom{k-1}{0} c_{k-1} + \binom{k}{1} a c_k + \binom{k+1}{2} a^2 c_{k+1} \right]$$

$$+ \dots + \frac{1}{(x-a)^n} \left[ \binom{0}{0} c_0 + \binom{1}{1} a c_1 + \dots + \binom{k+1}{k+1} a^{k+1} c_{k+1} \right]$$

$$= \frac{1}{(x-a)^{n-(k+1)}} \sum_{p=0}^{k+1} (x-a)^{-p} \sum_{j=0}^P \binom{k+1-p+j}{j} a^j c_{k+1-p+j}$$

and the assertion follows.

It is evident that the  $c_i$ ,  $i=1, \dots, k$ , are simply the coefficients of the powers of  $x$  in the numerator of  $F(x)$ . Thus if

$c_0, \dots, c_k \in \mathbb{Z}$ , and  $k < n$  then

$$(4) \quad \frac{c_k x^k + c_{k-1} x^{k-1} + \dots + c_0}{(x-a)^n} = \sum_{p=0}^k \sum_{j=0}^P \binom{p-j}{j} a^{p-j} (x-a)^{j-n}$$

The argument follows in a similar fashion as for (1). Of course the following integration formula is immediate

$$\int \frac{c_k x^k + c_{k-1} x^{k-1} + \dots + c_0}{(x-a)^n} dx = \frac{1}{(x-a)^n} \sum_{p=0}^k \sum_{j=0}^P \binom{p}{j} a^{p-j} \frac{(x-a)^{j+1}}{j+1-n} + C.$$

VERTICAL STRATIFICATION OF THE SALAMANDERS  
*ANEIDES AENEUS* AND *PLETHODON GLUTINOSUS*  
(CAUDATA: PLETHODONTIDAE)<sup>1</sup>

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ABSTRACT

Two species of plethodontid salamanders, *Aneides aeneus* and *Plethodon glutinosus*, inhabit crevices in sandstone cliffs in Tishomingo County, in extreme northeastern Mississippi. Field observations indicated a stratified distribution of the two species in the cliffs, with *A. aeneus* occupying the highest mean levels. In laboratory tests, *A. aeneus* positioned itself at a significantly higher level than did *P. glutinosus*.

INTRODUCTION

The plethodontid salamanders, *Aneides aeneus* and *Plethodon glutinosus*, inhabit horizontal and vertical crevices in sandstone cliffs in Tishomingo County, in extreme northeastern Mississippi. These crevices presumably serve as microhabitats allowing the salamanders to survive in an otherwise adverse environment.

Field observations over a 20-year period led to the general impression that *A. aeneus* usually occupies higher positions on the cliff, and to the hypothesis that vertical stratification in the cliffs alleviates competition for space, food, and moisture.

Vertical stratification among salamanders has been suggested or implied by Brandon and Huheey (1971), and Brode and Gunter (1958). Stratification of *A. aeneus* and *P. glutinosus* in cliff habitats was apparently first suggested by Woods (1968). He observed that *P. glutinosus* was most often seen utilizing the lowest crevices and rarely occurred in the same crevice as *A. aeneus*. Woods believed that *A. aeneus* escaped direct competition with *P. glutinosus* and other salamanders by use of a different microhabitat.

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## Vertical Stratification of Salamanders

Netting and Richmond (1932) found *A. aeneus* in Virginia to occupy crevices from 3 to 15 feet above the ground and they concluded that it was more common in higher crevices. Gordon (1952) found that *A. aeneus* rarely occurred in the same crevice with *Plethodon jordani melaventris*, and suggested that the ability to endure greater desiccation may allow *A. aeneus* to occupy relatively dry crevices, such as may be found at higher levels in a cliff. A tendency toward vertical stratification has been observed among other plethodontids such as *Desmognathus monticola* and *D. quadramaculatus* (Brandon and Huheey, 1971).

Orientation of movement on vertical cliffs, ability to climb on a vertical sandstone surface, and behavior in competitive situations may be factors involved in stratification. It is the purpose of this paper to report field observations and laboratory tests documenting vertical stratification of *A. aeneus* and *P. glutinosus*.

### METHODS AND MATERIALS

*Field Studies.*--Measurements of vertical distance from the base of the cliff to each salamander were made. It was also recorded whether each salamander was in a horizontal crevice, a vertical crevice, or on the vertical rock face. Most observations were made at night since these generally nocturnal animals are more easily observed after dark. Data were collected from late February through June, and in October and November.

*Laboratory Studies.*--Stratification tests were performed with *A. aeneus* and *P. glutinosus* to determine distance of upward movement and final position taken under stable conditions of light, humidity, and temperature. Each species was tested separately in groups of five animals. Tests were then repeated with five individuals of each species present.

Individuals to be tested were placed in separate metal containers at the time of collection on April 15. They were maintained in these containers at 18° C under a 12-12 photoperiod until tested.

The test chamber was a rectangular box of rough pine plywood with internal measurements of 27.5 x 27.5 x 143 cm high. Nine horizontal crevices, 12 mm wide, 12 mm deep, and 14 cm apart, were formed in each of the four walls. The lowest crevice was 14 cm from the floor. The roof of the chamber had a small adjustable window to allow dim light conditions with slight visibility. Temperature of the chamber was maintained at 21° C. Humidity within the chamber was kept high by wetting the walls at the start of each test, and by placing a dish of water on the floor. One wall of the chamber was held in place by springs and was removed to observe salamander locations.

During testing, subjects were placed on the floor of the chamber and individual positions were scored hourly. Little movement occurred after four hours; therefore, vertical height above the floor at four hours was recorded as the final height for each salamander.

## RESULTS

*Field Studies.*--Vertical height of 230 *Aneides aeneus* ranged from 30.5 to 396 cm above the base of the cliff. Mean height was 125.68 cm (S. D. = 59.61, S. E. = 3.94). Forty measurements of vertical height of *Plethodon glutinosus* ranged from 0 to 168 cm. Mean height was 60.70 cm (54.76, 8.66).

Differences between the mean heights were tested for significance by analysis of variance (Nie et al., 1975). Mean vertical height of *A. aeneus* was significantly greater than that of *P. glutinosus* ( $P < 0.001$ ,  $F = 41.47$ ).

*Laboratory Studies.*--In 20 observations of *A. aeneus* alone, final vertical height from the chamber floor ranged from 0 to 137 cm. Mean height was 78.49 cm (61.01, 14.0). In 45 observations of *P. glutinosus* alone, vertical height ranged from 0 to 137 cm. Mean height was 18.62 cm (44.93, 15.90). These means were also significantly different ( $P < 0.05$ ,  $F = 6.92$ ).

Thirty-five measurements of vertical height of *A. aeneus* tested with *P. glutinosus* ranged from 0 to 122 cm, with a mean of 31.5 (29.79, 5.03). Thirty-seven measurements of *P. glutinosus* tested with *A. aeneus* ranged from 0 to 76.2 cm, with a mean of 17.5 (15.95, 2.62). These means were also significantly different ( $P < 0.05$ ,  $F = 6.26$ ).

The mean height of *A. aeneus* when tested alone was significantly greater than when tested in the presence of *P. glutinosus* ( $P < 0.001$ ,  $F = 14.76$ ). The mean height of *P. glutinosus* when tested alone was not significantly different from that in the presence of *A. aeneus* ( $P > 0.05$ ,  $F = 0.016$ ).

## DISCUSSION

Field observations and laboratory tests indicated a distinct vertical stratification of *A. aeneus* and *P. glutinosus*. Under laboratory conditions, *A. aeneus* positioned itself at a significantly higher level than did *P. glutinosus*. *Aneides aeneus* climbed even higher in the absence of *P. glutinosus*.

Laboratory tests have shown that *A. aeneus* has a significantly greater climbing ability than does *P. glutinosus* (Cliburn and Porter 1986). *Aneides aeneus* also has a tendency to climb upward on a vertical substrate (Baltar 1983). Since *P. glutinosus* has a lesser ability to climb vertical surfaces, the test chamber was constructed so as to remove some of the physical barriers to climbing in order to more accurately distinguish between climbing and stratifying tendencies. In spite of its ability to climb to any height in the chamber, *P. glutinosus* reached a much lower mean level than did *A. aeneus*, although some did reach the top crevice. We conclude that physical characteristics of this species are not a serious barrier to climbing. Since the presence or absence of *A. aeneus* caused no significant difference in mean vertical height of *P. glutinosus*, we further conclude that the low positions



## Vertical Stratification of Salamanders

assumed by *P. glutinosus* were not influenced by *A. aeneus*, but were the result of innate tendencies.

In the natural cliff habitat *P. glutinosus* was usually found in narrow vertical crevices, into which it may have climbed by having its back as well as its belly in contact with a wall, or in horizontal crevices which at one end were in contact with the cliff base due to the slope of the forest floor. Entry into these horizontal crevices would not involve climbing a vertical wall.

The significantly lower positions taken by *A. aeneus* in the test chamber when in the presence of *P. glutinosus* may be explained only by hypotheses. Since *A. aeneus* is able to climb in any direction on a vertical wall and is physically capable of occupying virtually any crevice in nature (Cliburn and Porter 1986), it may actively search for the most favorable crevices. Since *A. aeneus* has a greater tendency to climb than does *P. glutinosus* (Baltar 1983), it may be that when the two species were placed together in the chamber, *A. aeneus* was the first to climb. The starting point for all specimens was the floor of the chamber and the lower crevices were probably the first to be explored and occupied by *A. aeneus* as resting places or home sites. Should *P. glutinosus* later enter an occupied crevice, *A. aeneus* may have passively defended the space by remaining stationary, or at least close by, thus preventing its own further upward movement.

Vertical stratification of *A. aeneus* and *P. glutinosus* may result from differences in climbing ability (Cliburn and Porter 1986), in tendency to climb and to orient in an upward direction (Baltar 1983), and in resistance to desiccation or its effects (Gordon 1952). Its functions may be to reduce competition for space and food, and to reduce the role of *P. glutinosus* as a potential predator on the young and eggs of *A. aeneus*.

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THE EVOLUTION OF SOUTHERN BENEVOLENT  
SOCIETIES WITH EMPHASIS ON ALABAMA<sup>a</sup>

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There has been little, if any, recognition that in many ways the American benevolent societies were the counterpart of the European friendly societies which have been the subject of so much research. The many striking similarities between these mutual assistance organizations indicate that the American benevolent societies which flourished in the 1700's and 1800's developed from the same needs and traditions as the European societies and served many of the same purposes. Furthermore, the American benevolent societies were forerunners of industrial life insurance companies in the United States. In fact, some of these societies ultimately were converted into insurance companies.<sup>1</sup>

Discussion will be limited to American benevolent societies in the Southern United States with emphasis on those organized in Alabama. Comparisons between the Alabama societies which developed in the nineteenth century and the English, Scottish, and Irish sick societies will be presented in order to provide a clear understanding of the similarities between these two groups of mutual aid associations and to indicate how the American societies evolved from their European forerunners. The early settlers in Alabama, who were predominantly English, Scottish, and Irish by descent, brought with them the old established traditions of the friendly societies and fraternal orders and adapted these traditions to meet their needs in this country.

A concise sketch of the salient features of the English, Irish, and Scottish friendly societies provided a basis for understanding the evolution of the American benevolent societies. The friendly societies began as small local mutual aid associations, which members of the wage-earning class organized around a church or chapel or a particular public-house.<sup>2</sup> In Scotland, the nucleus of the society was a particular occupation or trade.<sup>3</sup> Fellowship and conviviality soon emerged as an important feature of these societies, but the primary objective of the early local mutual aid associations was to provide security during illness.<sup>4</sup> Somewhat later, the mutual aid associations began to supply burial insurance and to overcharge premiums, returning the excess to the members in a lump sum at the end of the year which represented a form of forced saving. These were the three great objectives of the English, Irish, and Scottish friendly societies.<sup>5</sup>

It should be emphasized, however, that friendly societies flourished throughout Europe where the problem of disability income, and to some extent, medical expenses were met by the formation of friendly

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societies which were usually known as "sick societies." In short, the tradition of mutual aid among members of the society associated with strong bonds of brotherhood was not confined to England, Ireland, and Scotland. By the 1840's, friendly societies had also proliferated in France, Denmark, Germany, Austria, Belgium, and Switzerland.<sup>6</sup> These societies were extremely diverse in terms of their form of organization, focal points of organization, and goals.

In fact, a broad voluntary mutual aid movement began with the organization of sick clubs in England, Scotland, and Ireland during the sixteenth and seventeenth centuries.<sup>7</sup> This mutual aid movement gradually broadened to include several different areas of endeavor.<sup>8</sup> The local mutual aid associations and the assortment of fraternal orders were soon accompanied by savings banks,<sup>9</sup> the cooperative movement,<sup>10</sup> and trade unions. During the nineteenth century, the friendly societies of all varieties predominated in the voluntary mutual aid movement.

Gradually, the small local friendly societies evolved into a great variety of organizations, some with a federal form of government<sup>11</sup> and others with a unitary form of government.<sup>12</sup> Some offered assorted forms of specialized activity, such as teaching swimming and lifesaving.<sup>13</sup> But many continued as local sick clubs and served as the primary providers of health insurance for the wage-earning class. Considerable numbers of the friendly societies, however, began to develop elaborate rituals and regalia and a federal form of organization, involving branches known by different names, such as courts, lodges, or tents. The districts, and ultimately, the order as a whole, held jurisdiction over the branches. In short, the fraternal orders, often called the affiliated orders, evolved out of the small local friendly societies; and the fraternal orders also specialized in providing health insurance for their members.<sup>14</sup>

It is apparent that the voluntary mutual aid movement which was so important in Europe was also occurring in the United States with adaptation to the needs to Americans by modifying the old familiar European traditions to meet prevailing circumstances in this country. A tremendous variety of organizations appeared and included a wide assortment of local benevolent mutual aid societies, a few English and American fraternal orders,<sup>15</sup> a handful of struggling craft unions,<sup>16</sup> and a considerable number of savings banks.<sup>17</sup> The small local benevolent societies constituted the most numerous and pervasive component of the nineteenth-century voluntary mutual aid movement in the United States.

The American benevolent society was any local voluntary or incorporated non-profit association organized with or without capital stock and dedicated to providing mutual assistance for its members in the form of services and payments disbursed from admission fees, dues, and assessments levied on the membership. These societies were conducted solely for the benefit of their members and employed a representative form of government.

One of the earliest forms of the American benevolent societies were those organized around a particular trade or around a group of mechanics

without restrictions with regard to trade. This type of benevolent society was organized in the 1700's in the Eastern states and appeared in Alabama during the early 1800's. The foremost goal of these benevolent societies comprised of mechanics and tradesmen was to provide sick benefits, death benefits, burial benefits, and unemployment benefits.<sup>18</sup> Their activities soon expanded to include the encouragement of education, acting as a trade court, and acting as a credit and loan agency.<sup>19</sup>

In an attempt to discourage the organization of labor into trade unions for the purpose of imposing wage demands and conditions of employment upon employers, the various state legislatures in the Eastern states refused to charter any benevolent society which stipulated that it wished to engage in such protective activities and revoked the charters of those societies which attempted to fix wage scales or utilized the funds of the society as strike funds in violation of their charters. Such tactics were powerful weapons because benevolent societies needed incorporation in order to protect the funds of the society. Those which did not incorporate were considered to be partnerships at law, rendering them vulnerable to fraud and corrupt practices because no prosecution was possible except in the name of all the members. In contrast, a corporation constituted a *persona ficta* which could sue and be sued, thereby protecting the funds of the organization.

Consequently, the mechanics' benevolent societies were careful to restrict their functions to benevolent activities. The same group might form a "craft union" which attempted to impose wage scales and conditions of employment. However, this organization was distinct and separate from the benevolent society and was disbanded when its usefulness ended. The benevolent society existed on a continuous basis.

The earliest known benevolent society organized in Alabama around a group of mechanics or around a particular trade was the Mobile Mechanics Association established in 1836.<sup>20</sup> It is probable that others existed at an earlier date. The Mobile Mechanics Association followed the practice of the traditional English sick societies which required no waiting period after joining before benefits might be claimed.<sup>21</sup>

In Alabama, there were several focal points of organization for the benevolent societies in addition to those organized around a group of mechanics or tradesmen. During the period before the Civil War, one of the more common focal points of organization was a particular nationality or race, and this custom continued after the war. Examples of this group were the Mobile Spanish Benevolent and Mutual Aid Society,<sup>22</sup> the Société Française de Bienfaisance,<sup>23</sup> and the German Relief Association.<sup>24</sup> Benevolent societies organized around a church were less common. The Hebrew Benevolent Society of Montgomery founded in 1852<sup>25</sup> and the Lutheran Young Men's Association<sup>26</sup> founded in Mobile in 1893 illustrate this type of benevolent society.

Few benevolent societies for free blacks existed in antebellum Alabama. The Colored Draymen's Society was formed in 1840 in Mobile,<sup>27</sup> and during the 1850's, other black benevolent societies appeared.<sup>28</sup> After emancipation, however, black benevolent societies proliferated

rapidly. The focuses of organization were on groups of mechanics or tradesmen,<sup>29</sup> neighborhood groups,<sup>30</sup> and the black churches.<sup>31</sup> The churches furnished religious and moral guidance and were the center of many social functions in addition. Consequently, it was only natural that they should serve as the focal point around which numerous black benevolent societies were formed. In fact, the societies organized around a church constituted the most numerous kind of black benevolent society. The black societies were strictly segregated as a result of white discriminatory and exclusionist policies.

The benevolent societies had four primary goals. First, they were social organizations which engaged in a variety of social functions for members and their families, such as picnics, parades, pageants, and plays. Some societies required members to own colorful uniforms which they wore when representing their organization in a parade.<sup>32</sup> An annual celebration commemorating the founding of the society was the highlight of the social year for the members.<sup>33</sup>

The second goal of the American benevolent societies was to provide economic security for members and their families during illness. The Mobile Mechanics Association founded in 1836 provided disability income which was usually known as "sick pay."

*Members are entitled to \$12 per week when sick, on paying each to the fund the sum of \$2.00 per month.*

*By fostering institutions based upon the principle of mutual succor, the independent youth, when in health, by the contribution of a small pittance and the exercise of the noblest feelings of his nature lays up a store from whence he can claim pecuniary relief in the hour of distress and has a right to expect reciprocation of kind offices.<sup>34</sup>*

The third goal was to provide some form of burial insurance. In addition, many benevolent societies also sought to pay medical expenses. For example, the charter of the Hebrew Benevolent Society of Montgomery stipulated the following:

*The first appropriation of the funds of the society shall be for the purpose of a suitable grave-yard. No money of the society can be used for any other purpose than to pay doctors and for medicine for sick members, for the funeral expenses of a deceased member, or his wife and children...<sup>35</sup>*

By the 1890's, a few of the American benevolent societies placed a physician on retainer to care for sick members and contracted for the services of a druggist who agreed to perform his duties for the society at reduced rates.<sup>36</sup>

Like the English friendly societies, the foremost concern of Alabama's benevolent societies was to provide disability income and some form of burial insurance. The American societies, however, paid the cost of medicines and medical attendance by a physician as early as the 1850's

whereas the English friendly societies and fraternal orders did not provide these services until the 1870's.<sup>37</sup> Furthermore, most of the American benevolent societies supplied a form of nursing service for their members. The constitution of many American societies stipulated the following:

*Should any member or one of his family become so dangerously ill as to require watchers, two of the members shall be appointed to stay with such sick member six hours during the day and four hours during the night constantly, after which two others, and so on in rotations.*<sup>38</sup>

The fourth goal of the American benevolent societies was to supply group affiliation and acceptance from which flowed emotional support in addition to financial assistance during periods of family crisis. For example, upon the death of a member, the burial committee of the society was required to visit the family's home to make all arrangements for the funeral and to provide emotional support for the family.<sup>39</sup> In addition, a few societies paid benefits to the widow and surviving children of deceased members.

The black benevolent societies in Alabama, however, has somewhat different goals. These societies usually stressed "...the promotion of morals, intelligence, and education among the people, mutual aid to all our brotherhood, and assistance and care of the families of the deceased or indigent members and their families."<sup>40</sup> Compared to the white benevolent societies, the black societies stressed providing death benefits for widows and orphans much less and emphasized moral uplift and decent burial of the dead much more. Perhaps less concern for the welfare of widows and orphans reflected the strong demand among whites for domestic servants which enabled many black women to earn a better living than their husbands who were usually poorly paid unskilled laborers. In addition, black benevolent societies had a much stronger religious orientation and closer ties with churches than most white benevolent societies, reflecting the strong influence of the black churches.

It is apparent that the goal of the English friendly societies were very similar to the goals of the American benevolent societies. Both provided recreational activities for their members, but the American societies stressed family-oriented activities. And both the English and American societies were primarily concerned with providing some form of burial insurance and economic security during illness. The American societies, however, paid the cost of medications and medical attendance at an earlier date; they also provided a form of nursing service. Perhaps one of the greatest differences in objectives was the lack of a forced saving program among the American benevolent societies. The American organizations typically provided savings banking for their members during the early part of the nineteenth century. By the 1850's, savings banking was rapidly becoming a function of the domestic insurance companies in Alabama.

In addition, the American benevolent societies were similar in respects to the English local town friendly societies and local village

and country societies. Both the American benevolent societies and the English local friendly societies were independent and completely autonomous because they existed only on the local level and were not affiliated with a state or national organization. Both collected admission fees, dues, and assessments from which they paid various benefits to their members with sick pay being the benefit in greatest demand.

Although some authorities do not recognize the benefits which the American benevolent societies paid as constituting insurance,<sup>41</sup> these benefits were nevertheless the primary source of protection for the majority of Alabama's middle class, wage-earning class, and poor before the Civil War and remained popular until the 1880's or 1890's when industrial life insurance began to replace these organizations. Furthermore, the English friendly societies which are usually recognized as pioneers in mutual insurance paid benefits to their members which are generally recognized as insurance.

In contrast to the English friendly societies which were regulated in the public interest via a series of acts beginning with the Rose Act in 1793, the American benevolent societies were regarded as benevolent and charitable organizations which were totally unregulated in most cases. Alabama, like most other states, exempted the small local benevolent societies from regulation and taxation until after the Civil War. The absence of regulation constituted the really significant difference between the English friendly societies and the American benevolent societies. In fact, the lack of regulation was one of the factors which led to the decline of the American benevolent societies.

The features which accounted for the great popularity of the American benevolent societies were also the sources of their problems. They could provide cheap insurance because they were non-profit organizations which maintained no reserves, required no salesmen, and usually paid no salaries. But these societies did not observe actuarial principles. Two of their greatest errors lay in the local nature of the organization and in their failure to maintain reserves.

The concentration of risk in a single locality violated the basic tenets of insurable risk because the entire group may be subjected to illness simultaneously. The devastating yellow fever epidemics with their high rates of mortality during the period before the Civil War illustrated this problem.<sup>42</sup> In addition, reserves were not available to absorb the high losses during such periods, and the membership eventually became unable to bear the repeated assessments. Furthermore, the same situation evolved inevitably as a result of the advancing age of the membership. And finally, these problems were exacerbated by the increasing mobility of the American population after the Civil War. Those who moved lost membership in their benevolent society and might find themselves ineligible for membership in a society in their new location because of advancing age or poor health.

Complaints concerning the financial instability of the benevolent societies eventually culminated in the enactment of laws which made them subject to the regulation of the state insurance commissioner. For



example, Alabama enacted such a law in 1883.<sup>43</sup> As a result, the benevolent societies were forced to choose between eliminating their insurance benefits or operating as a commercial insurance company. Many societies continued to offer benefits until cited by the insurance commissioner. New societies were then formed and the process was repeated. Some managed to escape the unwelcome attention of the regulatory authorities for long periods of time. As a result, benevolent societies which offered insurance benefits existed in Alabama until well into the twentieth century. During the 1880's and 1890's, restrictive laws and the growth of industrial life insurance throughout the United States combined with increased industrialization to cause the rapid decline of the American benevolent societies.

It is apparent that the American benevolent societies and the English friendly societies were integral parts of a broad voluntary mutual aid movement which occurred in Europe and somewhat later in the United States. Both sprang from the same human needs for economic security during illness and for group affiliation and acceptance in a changing society. Both had similar goals and forms of organization. It is obvious that the American benevolent societies evolved from the friendly society traditions which European immigrants brought with them to the United States. Differences between these two types of mutual assistance organizations resulted from differences in the social, economic, and legal environments.

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<sup>1</sup>For example, the Liberty National Life Insurance Company of Birmingham, Alabama evolved from the Heralds of Liberty. Frank P. Samford, *The First Seventy-One Years of Liberty National Life Insurance Company* (Birmingham, Alabama: Liberty National Life Insurance Company, 1971), pp. 4-5.

<sup>2</sup>William Henry Beveridge, *Voluntary Action* (London: George Allen and Unwin Ltd., 1949) p. 27.

<sup>3</sup>*Ibid.*, p. 23.

<sup>4</sup>*Ibid.*, p. 29.

<sup>5</sup>The term friendly society is defined in accordance with the definition established by the Rose Act enacted by Parliament in 1793: "...a society of good fellowship for the purpose of raising from time to time, by voluntary contributions, a stock or fund for the mutual relief and maintenance of all and every the members thereof, in old age, sickness, and infirmity, or for the relief of widows and children of deceased members." 33 Geo. III, c. 54.

<sup>6</sup>George F. Hardy, "Friendly Societies," *Journal of the Institute of Actuaries*, XXVII (October, 1888), 263-9.

<sup>7</sup>The oldest friendly society still functioning is the Incorporation of Carters in Leith, England which was founded in 1555. Beveridge, pp.

21-23. A similar movement also occurred in other European countries. For example, Kulp notes that "...by the 1870's all Germany was covered (although not completely or thoroughly) by a network of 'multiplex organizations...old and new, compulsory and voluntary funds...' C. A. Kulp, *Social Insurance Coordination: An Analysis of German and British Organization*, a report prepared for the Committee on Social Security, Social Science Research Council, 1938), p. 76.

<sup>8</sup>Beveridge, p. 85.

<sup>9</sup>Although savings banks developed out of the mutual aid movement, the friendly society structure soon proved to be incompatible with savings banking. Thus, savings banks soon adopted the traditional bank structure and ceased to operate as a function of a friendly society. Savings banking soon came to supplement the insurance benefits of the friendly societies, providing a more flexible form of security for the working class. Ibid., pp. 112-4.

<sup>10</sup>In the 1820's and 1830's, Robert Owen attempted to set up communities in Britain and the United States based on the principle of cooperation whereby all the members of a community contributed regularly to a common fund. In return, the cooperative community dispensed food and lodging to the family, education, sickness and superannuation benefits. None of the early cooperative communities survived long, and breakup of the Owenite communities culminated in the formation of the Community Friendly Society in 1836. R. S. Garnett, *A Century of Co-Operative Insurance* (London: George Allen and Unwin Ltd., 1968), pp. 14-16.

<sup>11</sup>Federal is defined as "...a form of government in which certain states agree by compact to grant control of common affairs to a central authority but retain individual control over internal affairs." *Funk and Wagnalls Standard Dictionary of the English Language*, international ed. (1965), s.v.

<sup>12</sup>Beveridge defines the unitary form of organization as one without branches, having a single government and finance. Beveridge, p. 32.

<sup>13</sup>Ibid., p. 85.

<sup>14</sup>Ibid., p. 81.

<sup>15</sup>Several of the English fraternal orders appeared in the United States in the 1800's. For example, the Independent Order of Odd Fellows Manchester Unity was organized in Baltimore in 1819 under a dispensation of the Duke of York Lodge in Preston, England. The Odd Fellows Magazine, 1, no. 1 (October 1825): 2. The Manchester Unity was one of the earliest English fraternal orders to establish insurance for its members, beginning in the 1820's with a lodge sick fund and district funeral fund. P. H. J. H. Gosden, *The Friendly Societies in England 1818-1875* (New York: Augustus M. Kelly, Publishers, 1967), p. 103. In the United States, however, this fraternal order provided no benefits for its members except for voluntary contributions to needy brothers.

"Odd Fellows in the United States," *De Bow's Reviews* 7 (December 1849): 549. Before the Civil War, the American fraternal orders refused to provide insurance for their members because they considered that insurance was a commercial enterprise and, as such, was contrary to the spirit of brotherly love which such organizations were designed to promote. After the war, insurance furnished by fraternal benefit societies grew rapidly. The only known American fraternal benefit society formed before the Civil War which provided benefits was the Sons of the Order of Temperance which also granted membership to "persons of old age "...remain in a position of members not entitled to benefits." The Crystal Fount, July 1851.

<sup>16</sup>Evidence of the organization of only two national craft unions in Alabama before the Civil War has been discovered. The Typographical Union established a local in Mobile in 1850. James B. Kennedy, "Beneficiary Features of American Trade Unions," Johns Hopkins University Studies in Historical and Political Science, ser. 26., nos. 11-12 (November-December), 1908: 510. In 1861, the Iron Molder Union appeared in Irondale, Alabama. Jonathan Grossman, *William Sylvis, Pioneer of American Labor* (New York: Octagon Books, 1973), pp. 199-200. However, scattered references to small local craft unions appeared occasionally.

<sup>17</sup>During the Period before the Civil War, many of the small local benevolent societies provided savings banking for their members. The benevolent societies, however, suffered from financial instability. So, consequently, by the 1850's, savings banking was rapidly becoming an adjunct service of the domestic insurance companies in Alabama.

<sup>18</sup>John R. Commons, *History of Labor in the United States*, 2 vols. (New York: Macmillan Company, 1935), 1: 80-4. In England, the term "friendly society" referred to a mutual assistance organization whereas the term "benevolent society" referred to a charitable society dedicated to helping needed persons who were not members of the society. Beveridge, p. 353.

<sup>19</sup>Commons, 1:80-4.

<sup>20</sup>*Mobile City Directory for 1839* (Mobile: R.R. Dade's Printing Office, 1839), p. ix.

<sup>21</sup>The Scottish sick societies were regarded as charitable institutions which were utilized after the member's private funds were exhausted. These sick clubs had a waiting period, some being as long as five years. Gosden, p. 101.

<sup>22</sup>"Declaration of Incorporation and Association of the Mobile Spanish Benevolent and Mutual Aid Society," filed in the Office of the Secretary of State, 3 May 1871. Department of Archives and History, Montgomery, Alabama.

<sup>23</sup>"Declaration of Incorporation and Association of the Société Française de Bienfaisance," filed in the Office of the Secretary of

State, 2 December 1869. Department of Archives and History, Montgomery, Alabama.

<sup>24</sup>"Declaration of Incorporation and Association of the German Relief Association," filed in the Office of the Secretary of State, 2 December 1869. Department of Archives and History, Montgomery, Alabama.

<sup>25</sup>*Alabama Acts* (1852), pp. 290-294.

<sup>26</sup>*Mobile City Directory for 1895*, p. 524.

<sup>27</sup>*Directory of Mobile* (1894) Vol. XXIX, p. 459.

<sup>28</sup>For Example, the Baymen's Benevolent Society was chartered in 1852. *Alabama Acts* (1852), p. 286. The Creole Union Benevolent Society was organized the same year. *Alabama Acts* (1852), p. 352.

<sup>29</sup>The Colored Zion Mechanics Relief Society illustrates this group. "Declaration of Incorporation of the Colored Zion Mechanics Relief Society," filed in the Office of the Secretary of State, 3 December 1869. Department of Archives and History, Montgomery, Alabama.

<sup>30</sup>The United Friends Association is an example of the neighborhood groups. "Declaration of Incorporation of the United Friends Association," filed in the Office of the Secretary of State, 5 July 1872. Department of Archives and History, Montgomery, Alabama.

<sup>31</sup>The Rising Star Societies were among the more popular names employed by the church-related benevolent societies. An example is the Rising Star Society of Osweechee, Alabama. *Constitution and By-Laws of the Rising Star Society of Osweechee, Alabama in Russell County* (Columbus, Georgia: Thos. Gilbert, Printer and Mercantile Stationer, 1892), p. 6. Rare Book Room, University of Alabama, Tuscaloosa, Alabama.

<sup>32</sup>*Charter, Constitution and By-Laws of the Manhattan Benevolent Association* (New Orleans: George Ellis, Stationer and Printer, 1892), p. 33. Rare Book Room, University of Alabama, Tuscaloosa, Alabama.

<sup>33</sup>For example, the Mobile Turners Association celebrated the thirteenth anniversary of its founding in 1868 with a parade, and address, and song and dance exercises followed by fireworks. *Mobile Daily Register*, 3 May 1868.

<sup>34</sup>*Mobile City Directory for 1839*, p. IX.

<sup>35</sup>*Alabama Acts* (1852), p. 290.

<sup>36</sup>*Charter, Constitution and By-Laws of the Manhattan Benevolent Association*, pp. 33-35. By the 1890's, benefits paid usually included a stipulated sum for weekly sick pay ranging between \$5.00 and \$7.00 and a sum to pay funeral expenses ranging between \$40 and \$50. *Charter Constitution and By-Laws of the Standard Benevolent Association* (New

Orleans: George Ellis, Printer, 1889), pp. 39-43. Rare Book Room, University of Alabama, Tuscaloosa, Alabama.

<sup>37</sup>Gosden, p. 140.

<sup>38</sup>Alabama *Acts* (1852), p. 290.

<sup>39</sup>Charter, Constitution and By-Laws of the Standard Benevolent Association, p. 38.

<sup>40</sup>"Declaration of Incorporation of the United Brothers of Friendship," filed in the Office of the Secretary of State, 14 December 1871. Department of Archives and History, Montgomery, Alabama.

<sup>41</sup>The generic definition of life insurance is as follows: "A contractual system of risk-sharing under which contributions are accumulated and redistributed to meet the economic consequences of the uncertain duration of life." Robert W. Osler and John S. Bickley, eds. *Glossary of Insurance Terms* (Santa Monica, California: Insurors Press, 1972), p. 87. The American benevolent societies did not issue a policy. Instead, the constitutions and by-laws specified that certain "benefits" would be paid on certain occasions.

<sup>42</sup>Yellow fever epidemics occurred in Mobile in 1819, 1824, 1825, 1827, 1829, 1837, 1842, 1843, 1844, 1847, 1851, 1853, and 1854. Jerome Gochran, M.D., "The Medical Profession," *Memorial Record of Alabama*, 2 vols. (Madison, Wisconsin: Brant & Fuller, 1893), 2:112. The mortality rate was usually about thirty to thirty-three percent. *Mobile Daily Advertiser*, 29 October 1953.

<sup>43</sup>Alabama *Acts* (1883), pp. 168-9.

## Notes

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## LETTER

The Executive Committee of the Alabama Academy of Science recently initiated an award for the outstanding article published in the *Journal*. Because this award is new and many readers may not be aware of it, I am writing this letter to bring it to their attention.

The award is the Carmichael Award, named in honor of Emmett Carmichael, one of the early and longtime leaders of the Academy. Consisting of a certificate and a check for \$250, the award is given to the author of the paper chosen to be the most outstanding during each calendar year. (In the case of multiple authors, the money is shared.)

I was privileged to serve as chair of the committee which chose the Carmichael Award win-

ners in 1986. The other committee members and I were impressed with the quality of several articles which were published in the *Journal* this past year. The winning paper was entitled "Escape Behavior of *Fundulus similis* when exposed to predation by *Callinectes sapidus*", and was co-authored by C. R. Kline, II, A. H. Williams, and D. L. West. They are to be congratulated for a fine piece of work.

I want to close by encouraging readers who have been considering submitting a paper to the *Journal* to give in to this added temptation and do it in 1987. Our *Journal* is not large but it does publish quality papers.

Stanley T. Jones  
Former Chair, Carmichael  
Award Committee

THE EFFECT OF A LOWER DRINKING AGE ON HIGHWAY DEATHS,  
INJURIES, AND ACCIDENTS IN ALABAMA<sup>1,2</sup>

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ABSTRACT

An interrupted time series multiple regression was used to evaluate the effect of the lower drinking age on highway death, injury, and accident rates from 1976-1979 in Alabama. The research fails to provide evidence that lowering the drinking age from 21 to 19 in 1975 had substantial influence on raising the injury rate on Alabama highways from 1976-1979. Conversely, this conclusion implies a raised drinking age may not be a panacea for teenage alcohol-related traffic accidents.

INTRODUCTION

Drunk driving is associated with approximately 25,000, or 50% of all annual U.S. highway fatalities (Kreig, 1982). Recently, there has been a public awakening to the frequencies of alcohol-related traffic casualties. Citizen action groups such as Mothers Against Drunk Driving (MADD) have been vocal proponents for the passage of laws and implementation of policies which could reduce the damage caused by drunk drivers. One such law is the 21 year old minimum legal drinking age.

THE THEORY

*How the Law Works*

Raising the drinking age is an attempt to indirectly reduce highway deaths, injuries, and accidents by restricting teenagers' access to alcohol. By restricting alcohol availability, it is assumed teenage drunk driving should be reduced. The supporting propositions are a peculiar mix of facts, assumptions, and values.

It is argued that with a legal drinking age of 18, 15 to 17 year olds acquire liquor from their older high school friends (National High-

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<sup>1</sup>Manuscript received 10 February 1987; accepted 24 March 1987.

<sup>2</sup>An earlier version of this paper was presented at the 1986 meeting of the Alabama Political Science Association. The author would like to thank officials in the Alabama Department of Public Safety and the Alabama Alcoholic Beverage Control Board for data they provided. The author gratefully acknowledges the assistance of Steven H. Haeberle in conducting this study and Mary Ellen Guy for comments on drafts of this report. The paper was written while the author was at the University of Alabama at Birmingham.

way Traffic Safety Administration (NHTSA), 1985b). Alcohol possessed by young teenagers is especially dangerous. Teenagers are more prone to alcohol-related crashes due to their verdant driving (Krieg, 1982) and drinking (Krieg, 1982; NHTSA, 1985a). Additionally, the preponderance of teenage driving is on weekend nights; the most dangerous time to drive (Krieg, 1982). The conclusion is that "drunk driving...has more serious repercussions for teens than for any other age group" (Vejnoska, 1982, p. 35).

The presumptions are 1) alcohol will not "trickle down" to young teenagers; and 2) that 18 to 20 year olds will consume substantially less alcohol under the 21 year old drinking age. It is assumed a reduction in consumption will produce a decrease in drunk driving. Of course, this optimistic forecast is contingent on a critical assumption: the law will be obeyed. Though the raised drinking age theoretically affects drunk driving through several intervening variables such as marketing practices of the beverage industry and drinking norms (see Wagenaar, 1981), the only viable variable is alcohol availability (Coursey, 1986).

A raised drinking age's effect through alcohol availability depends almost entirely on the general deterrence of the law. Will retailers "card" teenagers? Will teenagers ignore the law and attempt to acquire alcohol? Specific deterrents tied to a raised drinking age would probably not be effective due to the difficulty in catching violators. Most public safety laws, to which a raised drinking age is no exception, must rely predominately on moral obedience. Supporters of the 21 year old drinking age admit some youth below 21 will still acquire liquor. However, they believe most teenagers will be law abiding (NHTSA, 1985b).

#### *Some Problems with the Theory*

The assumption that a raised drinking age will produce a reduction in alcohol consumption, and less drunk driving, is questionable. There is evidence that teenagers regard drinking as a "rite of passage" from youth to adulthood (Vejnoska, 1982). Heavy peer pressure is exerted on teenagers to drink. As Borkenstein (in Organization for Economic Development and Co-Operation, 1971) finds, both drinking and driving satisfy intrinsic needs of young people. It is questionable whether teenagers will respect a law out of moral responsibility with the possibility of becoming a social pariahs. The raised drinking age does not attempt to reduce drunk driving by addressing these underlying motivations to drink.

Of course, the raised drinking age should increase search costs for alcohol (time, driving expenses). These search costs may deter the occasional teenage drinker but would probably have less, if any, effect on problem drinkers and/or alcoholics. Problem drinkers and/or alcoholics are overrepresented among fatally injured drivers (NHTSA, 1985a). Psycho-social characteristics of driving-while-intoxicated arrestees are similar to individuals eventually diagnosed as alcoholics (Donovan and Marlatt, 1982, p. 241). The "benefits" of alcohol for problem drinkers would probably outweigh search costs imposed by a raised drinking age.

## LITERATURE REVIEW

Despite the perceived problems with the assumptions bolstering the 21 year old drinking age, the majority of the literature supports the opinion that there is an inverse relationship between the minimum legal drinking age and teenage alcohol-related accidents (see NHTSA, 1985a). Most researchers find an increase in teenage alcohol-related accidents in states which lowered their drinking age during the late 1960's and early 1970's (NHTSA, 1985a).

Numerous studies have also been conducted measuring the effects of a raised drinking age. Most find a decrease in alcohol-related accidents when the legal drinking age is elevated. Table 1 lists some of these studies and their findings.

Table 1. Summary of Studies Evaluating the Impact of a Raised Drinking Age.

State	Findings	Researchers
Massachusetts	No effect	Roy and Greenblatt, 1981
Michigan	Accidents reduced	Wagenaar, 1981
Maine	Accidents reduced	Klein, 1981
Illinois	Accidents reduced	Maxwell, 1981
Nine States	Accidents reduced in eight states	Williams, et al., 1975
United States	States with lower drinking ages have more accidents involving injury	National Center for Statistics and Analysis, 1982
Massachusetts	Accidents reduced	Hingson et al., 1983

Notes: 1) Accidents reduced are teenage alcohol-related crashes.

2) Table from "Alcohol and Highway Safety 1984: A Review of the State of Knowledge" by the National Highway Traffic Safety Administration, 1984.

Some studies of the raised drinking age use control groups to control for other factors which may affect teenage alcohol related accidents and/or injuries and deaths (e.g., Wagenaar, 1981). Changes in the use of seat belts, weather, percentage of young drivers, and road usage, among other variables, may influence accident totals and/or resulting injuries and deaths. For example, during the economic recession of 1981-82, we would expect a substantial reduction in road use and hence, a substantial drop in accidents. Many studies account for these influences through a control group. Wagenaar (1981) compared a surrogate

## The Effect of a Lower Drinking Age

measure for 18-20 year old alcohol-involved accidents to the same surrogate for two older age groups, 21-24 and 24-45. Though obviously efficient, this control technique is only suitable if the influences equally affect the experimental and control groups. Since teenagers have less driving experience, they may be more susceptible to poor road conditions and high traffic density, among other factors, than adult drivers. If so, directly discounting the effects of these influences as independent variables in the methodology would be desirable.

Additionally, most studies fail to mention if the examined jurisdiction concurrently began proactive programs which may account for part of a reduction attributed to a raised drinking age. Alcohol education or "Project Life" programs by Students' Against Drunk Driving chapters (SADD) are largely ignored. At best, many of the reductions should be attributed to the combined effects of new teenage drunk driving countermeasures and a raised drinking age.

Another problem limiting the persuasiveness of these studies is the tendency to assess only the effect of a raised drinking age for a brief period. For example, Wagenaar's (1981) study measures the effects of a raised drinking age for its first year. The reported reductions in accidents, injuries, or deaths could be due more to transient economic factors such as a recession (NHSTA, 1985a) or to current public awareness of the dangers in drunk driving than the law itself. Traditionally, many public safety campaigns have evanescent effects due to transitory public awareness (e.g., Vaughn and Klein, 1984).

### A PROPOSAL AND HYPOTHESES

Clearly, there is a need for further evaluation of the 21 year old legal drinking age, considering the problems limiting the conclusiveness of previous research. Specifically, there should be an attempt to disallow the effects of public awareness and other programs concurrently begun with a raised drinking age. It would also be helpful to measure the effects of a change in the drinking age on accidents, injuries, and deaths in the same study. This would avoid inferring death and injury reductions from reductions in accidents as some authors have done (viz. Wagenaar, 1981). With these thoughts in mind, three hypotheses were developed.

- H1: There is an inverse relationship between the minimum legal drinking age and teenage alcohol-related highway deaths.
- H2: There is an inverse relationship between the minimum legal drinking age and teenage alcohol-related highway injuries.
- H3: There is an inverse relationship between the minimum legal drinking age and teenage alcohol-related highway accidents.

### METHOD

#### *Population Tested*

Alabama's experience with lowering the drinking age from 21 to 19 in July of 1975 was selected. The years 1971-1979, excluding 1975, were



used. 1975 was excluded since the yearly measurement of most control variables conflicts with the mid-year enactment of the law. A longer time series was not possible for two reasons. First, most control variable data are unavailable for before 1971. Second, using data from the 1971-1979 period, when public concern about drunk driving was practically nonexistent and stable in Alabama, would serve as a crude but presumably effective control for public awareness. Controlling for public awareness requires a time period encompassing stable public opinion such as 1971-1979. The time period was also chosen to match Brown's and Maghsoodloo's (1981) study of the effects of a lower drinking age in Alabama. Results agreeing with those of Brown and Maghsoodloo would offer good convergent validity.

### *Definition of Variables*

Three dependent variables were defined: highway deaths/million miles traveled, highway injuries/million miles traveled, and highway accidents/million miles traveled. Dividing the numerators by miles traveled controls for road use. Of course, using total highway data in the numerator of these dependent variables is less precise than using data on teenage alcohol-related accidents, injuries, or deaths, or some representative surrogate. Unfortunately, Alabama did not categorize highway data from teenagers (15-20 year-olds). Assuming there are no other significant variables besides those controlled for affecting highway accidents, injuries, or deaths, changes in the measures would indicate the effect of a lower drinking age. The control variables should account for changes in non-teenager accidents. Though this is a simplifying, tenuous assumption, it is necessary for the analysis.

Nine independent variables theoretically affecting accidents, injuries, or deaths were selected. Table 2 describes the independent variables, their theoretical relationship to the dependent variables, and their rationale for inclusion in this study.

### *Data Collection*

All of the dependent and independent variables were collected by year. The appendix details the data collection process.

### *Analysis*

Interrupted time series multiple regression was used to analyze the data. Though it is often asserted that regression is inappropriate with less than thirty cases, formal regression theory makes no such requirement. Parameter estimates are unbiased linear estimates regardless of the number of data points (e.g., Neter, Wasserman, & Kunter, 1985). However, a small number of data points requires relatively large estimated coefficients for statistical significance.

Three models, one of each dependent variable, were developed for testing the effects of the lower drinking age. Independent variables were placed in a model if the absolute value of their simple correlation to the dependent variable was at least .200 and the variable reduced the

# The Effect of a Lower Drinking Age

Table 2. Description and Rationale for Independent Variables.

Variables	Description	Relationship to Dependent Variables	Rationale
PCYDRV	Proportion of population between 15-24 years-old	Positive	Inexperience makes young drivers more dangerous
ALCCON	Ethanol consumed per citizen 15 and older in wet counties	Positive	Measure for drunk driving
SPEED	Average driving speed on flat rural highways	Positive	Speeding decreases driver control and increases severity of accidents
WEATHER	Inches of rain in Birmingham	Positive	Worsens road conditions
SEATBLT	Proportion of injured drivers wearing lap and shoulder belts	Negative	Decreases chance of injury or death in an accident
DRKAGE	Dummy variable 1=21 legal age 0=19 legal age	Negative	See text
INTALCY	Product of ALCCON and PCYDRV	Positive	Interaction of variables
INTSPALC	Product of SPEED and ALCCON	Positive	Same as above
INTSPY	Product of SPEED and PCYDRV	Positive	Same as above

standard error of the regression model. Multicollinear independent variables were combined through principal component analysis. A model was not accepted for evaluation of a hypothesis unless it explained a sizeable portion of the variance in the dependent variable ( $R\text{-squared} > .600$ ). The unstandardized regression coefficient (b) of the dummy variable for the legal drinking age (DRKAGE) was examined to judge the effects of the lower drinking age on the dependent variable.

## RESULTS

Many of the independent variables showed signs of multicollinearity ( $-.700 < r < .700$ ) and were combined into FACTOR 1. Table 3 lists the variables included in FACTOR 1 and the remaining independent variables used for the model building.

Table 3. List of Independent Variables After Principal Component Analysis.

FACTOR 1	Combination of PCYDRV, INTALCY, INTSPY, INTSPALC, and a factor for ALCCON containing a yearly time trend and DRKAGE
SEATBLT	
SPEED	
WEATHER	

- Note: 1) ALCCON was removed from the analysis due to the very strong correlation ( $r=.960$ ) to DRKAGE.
- 2) The proportion of variance accounted for in the included independent variables by FACTOR 1 is 0.956.

*Model for Deaths/Million Miles*

Three variables were included in the model: FACTOR 1, SPEED, and proportion of injured drivers using a lap and shoulder belt (SEATBLT). Table 4 lists pertinent information for the model.

Two interpretations accompany this model. First, despite the high amount of variance explained by the model, the negative unstandardized

Table 4. Regression Statistics for Model Predicting Deaths/Million Miles Traveled.

Independent Variable	Mean	b
FACTOR 1	2010.7769	-.0003
SEATBLT	.0080	-1.2602
SPEED	57.5750	.0028
R-Squared = .9922		
Standard Error of the Multiple Estimate = .001		
Durbin-Watson Statistic = 1.515		
Mean of Dependent Variable = .0049		

## The Effect of a Lower Drinking Age

regression coefficient for FACTOR 1 suggests the model may not be valid. It implies, for example, that as alcohol consumption increases (ALCCON) the highway death rate decreases. Since ALCCON's underlying concept is drunk driving, the unstandardized regression coefficient for FACTOR 1 implies increased drunk driving reduces the highway death rate. A second interpretation is that lower drinking age had practically no effect on Alabama's highway death rate when controlling for other influencing variables. The unstandardized regression coefficient for FACTOR 1 is practically zero, albeit in the wrong direction. Apparently, the lower drinking age had no effect on highway death rates in Alabama from 1976-1979. These two, perhaps equally defensible, interpretations make the results of this model inconclusive for evaluating the first hypothesis.

### *Model for Injuries/Million Miles*

Unlike the death rate model, FACTOR 1's unstandardized regression coefficient in Table 5 displays the theoretical positive direction.

Table 5. Regression Statistics for Model Predicting Injuries/Million Miles Traveled.

Independent Variable	Mean	b
FACTOR 1	2010.7769	-.0009
SEATBLT	.0080	-11.2987
SPEED	57.5750	.0134
R-Squared = .8625		
Standard Error of the Multiple Estimate = .0222		
Durbin-Watson Statistic - 1.8947		
Mean of Dependent Variable = 1.1480		

Examining the minute value of FACTOR 1's unstandardized regression coefficient, it appears the lower drinking age had no substantial effect on the highway injury rate in Alabama. The model was used to project the number of injuries uniquely attributable to the lower drinking age from 1976-1979 (Table-6). The numbers imply that the lower drinking age made practically no difference in the number of highway injuries.

### *Model for Accidents/Million Miles*

Only two independent variables were accepted for the accident rate model: FACTOR 1 and SPEED. SEATBLT was not considered since there is no theoretical basis for assuming seat belt usage affects accident rates. Table 7 lists the important regression statistics for the accident rate model.

Table 6. Actual and Predicted Injuries With and Without the 21 Year Old Drinking Age.

Year	Actual	Predicted	Predicted with legal age at 21	Difference
1976	29,091	29,158	29,150	8
1977	31,694	30,585	30,576	9
1978	35,118	35,015	35,005	10
1979	34,773	34,050	34,040	10

Table 7. Regression Statistics for Model Predicting Accidents/Million Miles Traveled.

Independent Variable	Mean	b
FACTOR 1	2010.7769	-.0002
SPEED	57.5750	.0446
R-Squared = .4715		
Standard Error of the Multiple Estimate = .0708		
Durbin-Watson Statistic - 2.6189		
Mean of Dependent Variable = 4.2664		

Examining Table 7 we find the model does not explain an acceptable proportion of the variance in the accident rate ( $R\text{-squared} < .600$ ). The assumption is that there are important variables affecting the accident rate not included in this model. We cannot have confidence in the magnitude or direction of FACTOR 1's unstandardized regression coefficient. The accident model is judged inadequate for evaluating the third hypothesis.

## DISCUSSION

The only clear implication from these models is that lowering the drinking age had no substantial effect on highway injury rates in Alabama. Since a lower drinking age apparently did not increase the highway injury rate, it is quite likely that a raised drinking age would not decrease the injury rate. Assuming the independent variables control for changes in other highway injuries, the results indicate teenage alcohol-related injuries may not have increased.

This inference differs from the conclusions reached by most studies of the 21 year old drinking age. There could be many reasons for the

conflicting results. First, some studies control for other influences on the dependent variable(s) through a control group as opposed to directly discounting the influences as independent variables (e.g., Wageenaar, 1981). This difference in control technique could be a factor in the dissimilar results, especially if the effects of these variables are not consistent across the control and experimental groups.

Second, most studies finding substantial reductions in highway injuries and deaths specifically examine teenage alcohol-related accidents. Normally, such studies use a more exact measure of the dependent variable(s). It is possible that alcohol-related accidents by teenagers did substantially rise when Alabama lowered its drinking age to 19 in 1975, and this study failed to discover this increase due to a concurrent decrease in teenage nonalcohol-related accident rates and/or a decrease in the accident rates by older drivers. Brown and Maghsoodloo's (1980) study indicates this fear may not be realistic. They found a statistically significant increase in the percentage of single car, alcohol-related accidents by 18-21 year olds as part of all alcohol-related single car crashes after Alabama lowered its drinking age in 1975. However, the percentage of teenage accidents in the classification increased from roughly 11-15% before the reduction to only 16-17% during 1976-1979. Arguably, these insubstantial results, using a more precise measure of the dependent variable, offer good convergent validity for the implications drawn from this study.

Finally, most of the studies supporting a 21 year old drinking age examine a change from 18 to 21, or vice versa, in the legal drinking age. Alabama changed its drinking age from 21 to 19. The one-year difference could have a sizeable influence on the "pass down" effect. Young teenagers are perhaps much less likely to have close friends who are 19 than 18 since 18 is the age of most high school seniors. Therefore, the access to liquor is possibly quite different when the legal drinking age is 19 instead of 18. If Alabama had lowered its drinking age to 18, a sizeable change in highway accident, injury, and death rates may have been found as 15-17 year olds gained better access to alcohol. However, most studies supporting the 21 year old drinking age do not consider the effects of a raised drinking age on 15-17 year olds. Hence, it is doubtful the difference in affected ages explains the variations in findings.

Assuming the results of this study are valid, what is the implication for the 21 year old drinking age? The implication is that the legal drinking age does not substantially affect teenage drunk driving. Peer pressure and the presumption among many teenagers that getting drunk is a "rite of passage" from puberty to adulthood are perhaps more important than obeying the law. Teenagers may perceive negligible enforcement and punishment for their illegal drinking.

It is perhaps insufficient to assume teenagers will obey a raised drinking age for its own sake. In the early 1970's, like many states, Alabama did not especially enforce the 21 year old drinking age. Public pressure was to reduce the drinking age. The old argument "if they are old enough to vote and fight for their country, then they are old

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enough to drink" was ringing in the ears of lawmakers and law enforcement officials. The results of this study, compared to recent ones, implies that the 21 year old drinking age is not effective unless the public thinks the law is justified. Deterrence begins with personal enforcement. Recent studies showing a reduction in teenage alcohol-related accidents have been conducted in an environment of public concern over drunk driving and alcohol consumption. The strong public support for the raised drinking age may be the reason for the effectiveness of the law and not the law itself. Teenagers may have become more aware of the dangers of drunk driving due to recent public awareness.

Changing drinking habits and attitudes of Americans during the 1980's could also explain the positive findings of recent studies. The indications are that Americans are drinking less alcohol. The recent strong enforcement of the Dram Shop acts may be encouraging bar owners to avoid serving alcohol to teenagers. Since consumption of alcohol at bars is a correlate of drunk driving (NHTSA, 1985a), enforcement of the Dram Shop acts may be responsible for reductions in teenage alcohol-related accidents attributed to the 21 year old legal drinking age.

Traditionally, public safety campaigns have been effective only as long as public attention is stirred (e.g., Vaughn and Klein, 1984). It is doubtful that proponents of teenage drunk driving countermeasures can keep the public attention indefinitely. Once the attention wanes, the perceived effectiveness of the raised drinking age could evaporate as well. If the 21 year old drinking age is to have a lasting effect, it will probably have to be coupled with programs targeted at underlying motivations of teenagers to drink. As the NHTSA states in discussing drunk driving, "the solutions are both complex and difficult -- there are no easy answers or magic bullets" (1982, p. 24). Proactive programs aimed at reducing peer pressure and educating teenagers about alcohol could be extremely helpful. Teenagers should be taught alcohol abuse is not "grown-up" or "cool." These countermeasures probably offer more hope of reducing teenage deaths due to drunk driving than a law on the books. The more teenagers can be encouraged not to abuse alcohol for their own sake, the more successful countermeasures to teenage drunk driving will likely be.

## CONCLUSIONS

The research fails to provide evidence that lowering the drinking age had any influence in substantially raising the injury rate or number of injuries on Alabama highways from 1976-1979. Attempts to evaluate the effect of the lower drinking age on highway deaths and accidents were both inconclusive and unsuccessful. The findings indicate the laws may not reduce teenage drunk driving when public attention on alcohol abuse is absent. The findings, however, are hardly conclusive. The imprecise measurement of the dependent variables is the primary reason for the careful limitation of these findings. At best, this study provides some indication that standing alone, a raised drinking age may not be a total solution to teenage drunk driving. The results support the need for proactive measures such as alcohol education and peer pressure reduction programs to combat teenage drunk driving, in conjunction with a raised drinking age.

## The Effect of a Lower Drinking Age

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### APPENDIX

#### *Dependent Variables*

Annual highway death, injury, and accident figures were obtained from the Alabama Department of Public Safety. Million miles traveled in



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the state was derived from estimates made by the Alabama Department of Public Safety.

### *Independent Variables*

PCYDRV for the years 1975-1979 was taken from the "Annual Population Estimates by Age, Race, and Sex for Alabama Counties 1975-1985" published by the University of Alabama's Center for Business and Economic Research (CBER). For the years 1971-1974, the percentage of young people was estimated using a linear time trend from the 1970 census to the 1975 estimate by CBER. Of course, it would be more precise to use the percentage of young licensed drivers in the state. However, changes in Alabama's licensing procedures in 1975 had a tremendous affect on this measure. Licensed drivers nearly doubled. Hence, licensing data would be very misleading as a measure of PCYDRV.

ALCCON's numerator included all wine, beer, and distilled liquor sales converted to gallons of ethanol. For wine and beer, data were obtained from the Alabama Wholesale Wine and Beer Commission. Distilled liquor figures were obtained from the "Alcoholic Beverage Control Board Annual Report(s)." Liquor sales from 1979 were estimated based on the time trend from 1971-1978. Both organizations obtained their figures from direct counting of sales and not from an estimate based on a unit tax on alcoholic beverages. ALCCON's denominator was derived from the CBER data.

SEATBLT is derived from accidents involving injuries since Alabama did not keep records on the use of seat belts for non-injury accidents. Since seat belts prevent injury, the measure probably underestimates the use of seat belts. However, the author received assurances from officials at the U.S. Department of Transportation's Office of Traffic Operations and the American Seat Belt Council that the measure would not bias the findings. In summary, seat belt usage is too important of a variable in explaining highway deaths and injuries to exclude (see Fladseth, 1984; National Traffic Safety Administration, 1982). It is more defensible to include this estimate of seat belt usage than no measure at all.

WEATHER is measured by inches of rainfall in Birmingham for each year. This information is obtained from the National Weather Service in Homewood, Alabama. Since there is less than five inches difference in rainfall per year between the various regions in the state, no attempt was made to weight the rainfall by miles traveled in each region.

SPEED is calculated as the annual estimated average driving speed on level, rural highways in Georgia obtained from the Department of Transportation's Office of Traffic Operations. Georgia's data are used as a proxy since Alabama did not measure highway speed until 1975. In comparing data from both states between 1975-1979, there is nearly a perfect correlation between each state's average driving speed. Hence, Georgia's data appear to be a good proxy for estimating average driving speed in Alabama.

RELATIONSHIP BETWEEN THE SCORES ON THE FIRST  
TEST AND THE FINAL COURSE GRADE<sup>1</sup>

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ABSTRACT

A study was conducted to see if a relationship existed between the scores achieved on the first test and the assigned final course grades for the students taking Elementary Algebra (Math 105) at Tuskegee University. The results revealed that (1) approximately 76% of the students who achieved an unsatisfactory grade (D or E (failing) grade) on the first test also received an unsatisfactory grade for the semester; and (2) D or E grades for these students were achieved, also, in the subsequent tests and on the final examination. Some of the reasons for this phenomenon have been explored in this paper, and methods for successfully handling this situation are suggested.

INTRODUCTION

While teaching an Elementary Algebra course (Math 105 at Tuskegee University) during the academic year 1984-85, the senior author noticed a progressive trend of failure among the students. Many students who failed the first test of the semester consequently failed the course for the semester. The authors decided to collect data for all sections of Math 105 and analyze it to see if the same general trend held for the combined classes, and to see if there was any statistically significant differences among various instructors of this course.

METHODS

Data from the fall semester for all sections of Math 105 were obtained from instructors who taught this course. Data from only the students who completed the semester were analyzed, using Analysis of Variance techniques. Cross-tabulation and correlation analyses were also performed between the test scores and the final course grade to determine if a trend existed.

RESULTS

Of 241 students who completed the semester, 129 students passed with a C or better grade, while 112 students achieved D or the failing F

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<sup>1</sup>Manuscript received 17 December 1986; accepted 19 February 1987.

<sup>2</sup>Formerly Satish Chandra; the family name, Misra, was readopted at the time of naturalization, partly to maintain connections with the roots and heritage.

grade. A grade of D or E is considered to be unsatisfactory at Tuskegee University since many students who achieve these grades are required to repeat the course. Therefore, unsatisfactory grades as referred to in this paper mean a grade of D or E; satisfactory grades imply a grade of C or better. A cross-tabulation of the final course grades versus grades in the various tests is given in Tables 1 through 5. The conclusions in summary form are interspersed among the tables.

Table 1. Cross-Tabulation of the Final Course Grades Versus Grades in the First Test

Grades on Test 1	Final Course Grades					Total
	A	B	C	D	E	
A	25	12	3	1	0	41
%	71.4	30.8	5.5	2.0	0.0	17.0
B	8	13	14	9	3	47
%	22.9	33.3	25.5	18.0	4.8	19.5
C	0	9	23	20	11	63
%	0.0	23.1	41.8	40.0	17.7	26.1
D	2	2	12	15	18	49
%	5.7	5.1	21.8	30.0	29.0	20.3
E	0	3	3	5	30	41
%	0.0	7.7	5.5	10.0	48.4	17.0
TOTAL	35	39	55	50	62	241
%	14.5	16.2	22.8	20.7	25.7	100.0

PASS (COURSE) and PASS (TEST No. 1) : 107 out of 151 @ 70.9%

PASS (COURSE) and D or E (TEST No. 1) : 22 out of 90 @ 24.4%

D or E (COURSE) and PASS (TEST No. 1) : 44 out of 151 @ 29.1%

D or E (COURSE) and D or E (TEST No. 1): 68 out of 90 @ 75.6%

\* There were no statistically significant differences between different sections or grading practices of the various instructors of the course. The tests were similar and identical final exams were administered to all students at the same time. This allowed the authors to pool the data across all the sections and the instructors.

\* Approximately 76% (68 out of 90) of the students who achieved an unsatisfactory grade on the first test also achieved an unsatisfactory final course grade.

# Scores on the first test and the final course grades

Table 2. Cross-Tabulation of the Final Course Grades Versus Grades in the Second Test

Grades on Test 2	Final Course Grades					Total
	A	B	C	D	E	
A	31	17	16	1	4	69
%	88.6	43.6	29.1	2.0	6.5	28.6
B	3	13	14	6	7	43
%	22.9	33.3	25.5	18.0	4.8	19.5
C	1	8	12	12	7	40
%	2.9	20.5	21.8	24.0	11.3	16.6
D	0	0	9	18	11	38
%	0.0	0.0	16.4	36.0	17.7	15.8
E	0	1	4	13	33	51
%	0.0	2.6	7.3	26.0	53.2	21.2
TOTAL	35	39	55	50	62	241
%	14.5	16.2	22.8	20.7	25.7	100.0

PASS (COURSE) and PASS (TEST No. 2) : 115 out of 152 @ 75.7%

PASS (COURSE) and D or E (TEST No. 2) : 14 out of 89 @ 15.7%

D or E (COURSE) and PASS (TEST No. 2) : 37 out of 152 @ 24.3%

D or E (COURSE) and D or E (TEST No. 2): 75 out of 89 @ 84.3%

\* Approximately 84% (75 out of 89) of the students who achieved an unsatisfactory grade on the second test also achieved an unsatisfactory final course grade.

\* Approximately 80% (94 out of 118) of the students who achieved an unsatisfactory grade on the third test also achieved an unsatisfactory final course grade.

\* Approximately 66% (100 out of 152) of the students who achieved an unsatisfactory grade on the fourth test also achieved an unsatisfactory final course grade.

\* Approximately 70% (112 out of 159) of the students who achieved an unsatisfactory grade on the final test also achieved an unsatisfactory final course grade.

\* The rate of unsatisfactory grades in the successive examinations increased with each test.

Table 3. Cross-Tabulation of the Final Course Grades Versus Grades in the Third Test

Grades on Test 3	Final Course Grades					Total
	A	B	C	D	E	
A	23	7	6	1	1	38
%	65.7	17.9	10.9	2.0	1.6	15.8
B	9	16	15	4	1	45
%	25.7	41.0	27.3	8.0	1.6	18.7
C	2	11	16	9	2	40
%	5.7	28.2	29.1	18.0	3.2	16.6
D	0	4	10	17	9	40
%	0.0	10.3	18.2	34.0	14.5	16.6
E	1	1	8	19	49	78
%	2.9	2.6	14.5	38.0	79.0	32.4
TOTAL	35	39	55	50	62	241
%	14.5	16.2	22.8	20.7	25.7	100.0

PASS (COURSE) and PASS (TEST No. 3) : 105 out of 123 @ 85.4%

PASS (COURSE) and D or E (TEST No. 3) : 24 out of 118 @ 20.3%

D or E (COURSE) and PASS (TEST No. 3) : 18 out of 123 @ 14.6%

D or E (COURSE) and D or E (TEST No. 3): 94 out of 118 @ 79.7%

\* Students who continuously achieved unsatisfactory grades still remained in the class and did not take advantage of dropping the course. Students in Math 105 classes are given two tests before the official drop date.

#### DISCUSSION

From the number of students shown who consequently failed the Elementary Algebra course (Math 105), it is seen that many continuously failed examinations throughout the term. The rate of failing grades in the successive examinations increased with each test. Also, the data show that if a student failed the first test, there was a 76 percent chance that the same student would fail the course. A similar trend was observed during successive semesters. Several observations of the problem as well as possible solutions follow:

##### 1. *Over/Underestimation*

It appears that students entering the college overestimate their chances of earning good grades and underestimate the amount of time they

## Scores on the first test and the final course grades

Table 4. Cross-Tabulation of the Final Course Grades Versus Grades in the Fourth Test

Grades on Test 4	Final Course Grades					Total
	A	B	C	D	E	
A	24	6	2	0	0	32
%	68.6	15.4	3.6	0.0	0.0	13.3
B	6	4	12	3	1	26
%	17.1	10.3	21.8	6.0	1.6	10.8
C	4	10	9	9	4	31
%	11.4	25.6	16.4	8.0	6.5	12.9
D	0	6	14	9	4	33
%	0.0	15.4	25.5	18.0	6.5	13.7
E	1	13	18	34	53	119
%	2.9	33.3	32.7	68.0	85.5	49.4
TOTAL	35	39	55	50	62	241
%	14.5	16.2	22.8	20.7	25.7	100.0

PASS (COURSE) and PASS (TEST No. 4) : 77 out of 89 @ 85.5%  
 PASS (COURSE) and D or E (TEST No. 4) : 52 out of 152 @ 34.2%  
 D or E (COURSE) and PASS (TEST No. 4) : 12 out of 89 @ 13.5%  
 D or E (COURSE) and D or E (TEST No. 4) : 100 out of 152 @ 65.8%

will have to spend studying. They seem to expect a magical transformation and do not understand the level of effort it will take to successfully pass a course. It is important to dispel this belief through intensive orientation of the students at the time they enter college and/or before they are preparing to enter college. Orientation should include the quantitative information of college requirements and what it takes to complete the requirements.

### 2. Lack of Funds for Personalized Education and Training Programs

The funds for educational and training programs have become less and less available. The Reagan Administration continues to withdraw funds from educational and training programs. Other funding sources, including private and other government agencies, have become scarce and highly competitive. As a consequence, a number of programs have been diminished. This has affected the individual attention that students have received who were not performing satisfactorily. A possible solution to this problem is to quantify the impact of a lack of funds on the education of our young people. After all, the strongest asset any nation or any economy has is the quality of its working individuals.

Table 5. Cross-Tabulation of the Final Course Grades Versus Grades in the Final Test

Grades on Test 5	Final Course Grades					Total
	A	B	C	D	E	
A	25	2	2	0	0	29
%	71.4	5.1	3.6	0.0	0.0	12.0
B	8	18	2	0	0	28
%	22.9	46.5	3.6	0.0	0.0	11.6
C	2	14	9	0	0	25
%	5.7	35.9	16.7	0.0	0.0	10.4
D	0	5	27	10	2	44
%	0.0	12.8	49.0	20.0	3.2	18.3
E	0	0	15	40	60	115
%	0.0	0.0	27.3	80.0	96.7	47.7
TOTAL	35	39	55	50	62	241
%	14.5	16.2	22.8	20.7	25.7	100.0

PASS (COURSE) and PASS (TEST No. 5) : 82 out of 82 @ 100.0%

PASS (COURSE) and D or E (TEST No. 5) : 47 out of 159 @ 29.6%

D or E (COURSE) and PASS (TEST No. 5) : 0 out of 82 @ 0.0%

D or E (COURSE) and D or E (TEST No. 5): 112 out of 159 @ 70.4%

How can business expect better performance from its workers, in general, with a growing lack of education? It appears that teachers need to (a) develop new strategies to improve performance; (b) get involved in research, especially, studies on students' performance; and (c) demonstrate that more funds and resources are needed to assist students who need individualized attention in mathematics.

### 3. *Lack of Quantitative Problem Solving Skills*

Inadequate preparation in application of quantitative concepts continues to be a major contributor to low-level performance. A significant number of students at Tuskegee University with aptitude and motivation become discouraged when extensive work does not yield commendable performance. Further, many students perform less satisfactorily because their levels of mastery of quantitative concepts and skills are too low to support their creativity. This quantitative literacy (QL) problem is immediate, in that it obstructs understanding of material presented by instructors and authors, in course work and extra-class materials. It is a long-term problem. The pace of college work is too demanding for most students to do anything more than try to survive the immediate

## Scores on the first test and the final course grades

problems rather than correct them. In fact, many problems related to QL are so subtle that students do not recognize them. Rather, they characterize the problems as "that book is hard to read", "I just made too many silly errors", "once I get some help getting started...", "I didn't know that was what it meant", etc. Many students feel that it is an external force that caused this "bad" grade. There appears to be a problem among the students pertaining to their attitudes toward the QL courses.

The problem is interdisciplinary. It may appear in any course -- English, Reading, History, Philosophy, Science -- in the form of resistance to reasoning. The QL problem may appear at the checkout counter where the work of a cashier is easily accepted. The constant use of computers to do calculations rather than learn how to estimate without the use of calculators or computers is a common practice. In many instances, less reading is done because of the growing use of charts, graphs, and percents.

A possible solution to this problem is to introduce an interdisciplinary quantitative literacy training (QTL) course required of all students entering college. The main ingredients of such a course should be reviewing selected quantitative support areas or in building background blocks in quantitative literacy through the use of QLT modules, Computer Assisted Instruction (CAI) modules or similar devices.

### 4. *Mental Block Related to a Service Course*

Based upon many years of teaching of mathematics service courses in universities, it is recommended that the first step toward the successful teaching of a service course in mathematics is to dispel the belief of, otherwise, good students in other disciplines that they have a 'mental block' to mathematics. It is true that before the first class meeting, many students have made up their minds about their results at the end of the course -- outright failure. They believe that they can never pass the course. They are taking the course because it is required by the University's general requirement, or the departments insist on the successful completion of the mathematics course as a prerequisite to a proper mastery of the material in their main courses of study. This feeling makes the students tense and nervous in class; thus they may not understand the course. The first step, therefore, would be to dispel this belief and get them to relax in class by the following methods:

1. Formulating and quantifying goals and objectives precisely
2. Providing students a balance of theory and practice
3. Convincing students through a wide variety of practical examples that the course is needed in their careers
4. Convincing students that teachers are there to teach and help them acquire useful knowledge--and not to fail them and make their lives difficult
5. Assuring students that with constant practice through assignments and solving problems, they will, very likely, do well in the course



6. Assuring students of teachers' willingness to keep office hours; availability of tutorial services and CAI and providing help in their solving any problems that they might find too difficult
7. Encouraging students to ask questions in class
8. Informing students that all examinations will be fair and that they may see or get their marked papers returned
9. Discussing the methods of evaluation of their performance at the beginning of the course and the number of assignments, tests, and examinations
10. Emphasizing that the assignments are to help in giving students sufficient practice
11. Emphasizing various learning processes, such as (a) learning by reading, (b) learning by listening, (c) learning by observation, and (d) learning by doing

Indeed, the list can go on and on. Many instructors of service courses in mathematics have been very successful in the execution of their duties without any formal training in teaching practices. Here "success" is taken to mean the maintenance of the interest and understanding of students throughout the course. Teachers of mathematics at Tuskegee University seem to think that teaching is an art which can be taught and learned but, also, can be acquired through strict adherence to the simple rule "teach others as you would like to be taught". Thus, a teacher is likely to be successful if he/she is concerned and is committed to the discharge of his/her duties.

Finally, service courses have a significant role to play in the academic community. They should: (a) be alive, (b) use real problems, (c) be taught by 'good' instructors, and (d) serve as a motivation for putting mathematicians to work as servants of the sciences.

#### ACKNOWLEDGEMENTS

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#### APPENDIX A BACKGROUND OF TUSKEGEE UNIVERSITY STUDENTS

The 1984-85 freshman class of Tuskegee University consisted of approximately 750 students. About one-fourth of the students came from Alabama and another one-fourth came from other southern states. The

## Scores on the first test and the final course grades

remaining one-half came from other states and several foreign countries. The average high school grade point average was 2.92/4.0. The average verbal SAT score was 336 and the average mathematics score was 372. All Tuskegee University students must take at least one mathematics course with most disciplines requiring at least two mathematics courses. Approximately one-fourth of the freshmen had to take an introductory algebra course because of their lack of adequate high school preparation. From this population of students who had to enroll in an introductory algebra course, about 20 percent were in curricula requiring college algebra and trigonometry. The introductory algebra course is a preparatory course for college algebra and trigonometry. Students receive credit for the course but it is not counted into the hours for meeting graduation requirements.

### APPENDIX B ELEMENTARY ALGEBRA (MATH 105) COURSE DESCRIPTION

Operation with Signed Numbers (Addition, Subtraction, Multiplication, Division); Commutative Properties; Associative Properties; Operation with Zero; Powers of Signed Numbers; Roots of Signed Numbers; Order of Operations; Grouping Expressions; Evaluating Expressions Containing Variables; Evaluating Formulas; Laws of Positive Exponents, Operation with Polynomials (Addition, Subtraction, Multiplication, Division); Solving Linear Equations in One Unknown; Solving Linear Inequalities in One Unknown; Conditional Equations, Identities, and Equations with No Solution; Changing Word Expressions into Algebraic Expression; Changing from Symbols to Word Expressions; Solve Word Problems, Ratio and Proportion; Percents; Variation; Prime Factorization; Greatest Common Factor; Factoring by Grouping; Factoring Difference of Two Squares; Factoring Trinomials; Solving Equations by Factoring; Solve Word Problems Involving Products and Factoring; Simplifying Algebraic Fractions; Multiplication and Division of Fractions; Adding Like Fractions; Least Common Denominator; Adding Unlike Fractions; Complex Fractions; Solving Equations Having Fractions; Solve Literal Equations; Solve Word Problems Involving Fractions; Rectangular Coordinate System; Graphing Straight Lines; Equations of Straight Lines; Solve Systems of Equations by Graphical Method, Addition-Subtraction Method, and Substitution Method; Solve Word Problem Using Systems of Equations; Negative and Zero Exponents; General Rule of Exponents; Square Roots; Simplifying Square Roots; Multiplying and Dividing Square Roots; Adding Square Roots, Radical Equation; Solving Quadratic Equations by Factoring; Incomplete Quadratic Equations; The Quadratic Formula.

PARALLEL DISTRIBUTION OF SISTER CHROMATID EXCHANGES  
AND CHROMOSOMAL ABERRATIONS IN HUMAN LYMPHOCYTE  
CULTURES EXPOSED TO CHLORPROMAZINE<sup>1</sup>

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ABSTRACT

The effect of chlorpromazine hydrochloride (CPZ) on the incidence of sister chromatid exchanges (SCE's) and chromosomal aberrations was investigated using the short-term human peripheral blood assay. Lymphocytes cultured in growth medium containing ten-fold increases in the concentration of CPZ (ranging from 0.05 to 5.00 mcg/ml) exhibited dose-dependent decreases in cellular proliferation but had little or no effect on the incidence of chromosomal aberrations and SCE's. These results suggest that while CPZ exhibits variable SCE responses in different donors, similar cytogenetic responses are observed when both SCE's and chromosomal aberration frequencies are assessed within a given donor.

INTRODUCTION

The current status of chlorpromazine (10-(3-dimethylaminopropyl)-2-chlorophenothiazine), as a clastogenic agent remains unclear. The results of experiments thus far are contradictory with respect to the ability of chlorpromazine (CPZ) to induce morphological changes in chromosomes when chromosomal aberrations and sister chromatid exchanges (SCE's) are used as separate cytogenetic end-points. A significant increase in chromosomal aberrations was initially reported in human lymphocytes after exposure to CPZ by Cohen et al. (1967) but these results were not substantiated by subsequent studies (Cohen et al., 1969 and Nielsen et al., 1969). Results from other mammalian systems are equally contradictory. Kelly-Garvert and Legator (1973) observed increases in the frequency of chromosomal aberrations in cultured Chinese hamster cell lines exposed to therapeutic levels of photoactivated CPZ. In contrast, Speit and Vogel (1979) using a similar cell line reported as increase in SCE's in the absence of visible light treatment. Cohen (1969) noted that CPZ concentrations that fell well within the range found in the plasma after moderate therapeutic use suppressed lymphocyte

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<sup>1</sup>Manuscript received 8 December 1986; accepted 14 January 1987.

proliferation. Kamada et al. (1971) reported a decrease in blast transformation but an increase in the mitotic index when cycling and non-cycling lymphocytes were exposed in culture to similar dose levels. In the largest study reported to date, Crossen and Morgan (1982) observed considerable variation in the cytogenetic responses of donor cells following *in vivo* or *in vitro* exposure to CPZ when SCE frequency alone was used as an indicator of clastogenicity. CPZ is a widely prescribed psychopharmaceutical agent that has been used in the therapeutic regime of more than 100 million persons (Legator and Zimmering, 1975). Since it has been implicated in the formation of chromosomal aberrations and SCE's in many separate studies, this study was initiated to characterize both SCE and chromosomal aberration responses within a given donor.

## MATERIALS AND METHODS

### *Cell Culture*

Peripheral blood samples were drawn by venipuncture from two donors (one male and one female from a pool of healthy volunteers ranging in age from 21-32 years) and white cell counts were performed electronically (Coulter-Electronics). The whole blood samples were centrifuged (150 x g) and 0.8 ml of the leukocyte-rich plasma inoculated into 9.2 ml Chromosome 1A growth medium (GIBCO). Chlorpromazine hydrochloride (Sigma) was added to each culture at the time of initiation and the cells were exposed to continuous treatment for 48 to 72 hours. Stock solutions of CPZ were prepared in distilled water, filter sterilized, and serially diluted in growth medium. Finally, 0.25 ml of the sterile solutions was added to 9.75 ml of cell suspension to obtain the desired final concentrations.

Two control cultures were also setup: one received no chemical treatment, the other was treated with 0.2 mcg/ml mitomycin C (MMC, Sigma) to serve as a positive control. Control cultures received 0.25 ml of the growth medium or MMC. Lymphocytes were inoculated into 25 cm<sup>2</sup> flasks, incubated in the dark at 37°C, and cultured in a humidified incubator with 5 percent CO<sub>2</sub> enrichment, pH 7.2. After a terminal 2.5 hour exposure to colcemid (0.2 mcg/ml), the cells were collected by centrifugation, exposed to hypotonic treatment (0.075 M KCl), and fixed in acetomethanol (1 part glacial acetic acid to 3 parts absolute methanol). Air-dried metaphase preparations were coded to eliminate observer bias and scored directly through the microscope using the high power objective (100X).

### *Chromosomal Aberrations*

Well-spread first-division metaphases collected after 48 hours in culture, were randomly selected and scored for chromosomal aberrations. At least 300 metaphases were scored in control and 250 in CPZ-treated cultures. Classification of lesions as either chromatid- or chromosome-type was based on the position of the lesion and the involvement of one or both sister chromatids (Sorsa, 1980). An alteration involving the long or short arm of a sister chromatid was classified as a chromatid aberration. Both chromosome gaps (discontinuities of chromatin material

in a chromosome without displacement of the distal portion) and breaks (discontinuities of chromatin with displacement of the broken segments) were scored and included as aberrations in the calculation of the total number of chromosomal aberrations (Brogger, 1982). The counts of aberrations were arranged in  $2 \times 2$  contingency tables and Fisher's exact test used to determine whether the distribution of aberrations in metaphase preparations exposed to varying drug treatments differed from the untreated controls.

Mitotic index determinations were made by scoring evidence of mitotic activity in a random selection of 2000 consecutive mononuclear cells per treatment.

### *Sister Chromatid Differentiation*

Lymphocyte cultures set up for sister chromatid differentiation were exposed for 72 hours to BrdUrd (20 mcg/ml 5-bromo-2'-deoxyuridine, Sigma) supplemented medium and stained to differentiate sister chromatids by the hot sodium phosphate procedure of Korenberg and Freedlander (1974). Air-dried metaphase preparations were aged one to three days at room temperature, incubated for 15 minutes in 1 M phosphate buffer, pH 8.2 at 89°C, rinsed in an identical solution at 25°C, and stained in 4% Giemsa (Gurr's R66) for 5 minutes.

Whenever possible, 40 metaphase spreads were analyzed for each drug treatment. At least 20 well-spread metaphases from each donor were analyzed per treatment and only chromosome preparations containing 45-46 centromeres were scored. The data were submitted to an analysis of variance (ANOVA) and Duncan's Multiple Range test was used to determine whether treated cultures showed significant differences from the untreated controls.

## RESULTS

The frequencies and types of chromosomal aberrations observed in control and treated cultures are shown in Table 1. CPZ treatment produced little or no increase in the aberration frequencies. Breaks (discontinuities of chromatin with displacement of the distal portion) were the least frequently observed lesions while gaps (discontinuities without displacement of the broken segments) were most frequently observed and constituted over 90% percent of all morphological aberrations (Figure 1). Discordance was observed in donor response to CPZ-dose effects, however, concordance was observed in the total number and types of aberrations when viewed over all concentrations and cultures.

While scoring slides from 72-hour cultures for changes in the frequency of sister chromatid exchanges, we noted the occurrence of polyploid nuclei in CPZ-treated cultures (Table 1). Although the total number of polyploid cells was in the range expected for untreated controls, it is worth noting that at least one polyploid metaphase was observed at each dose level and no polyploid mitoses were observed in control cultures.

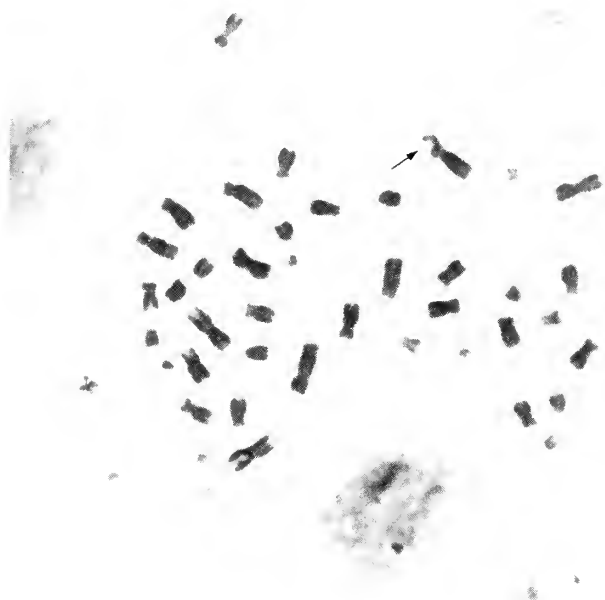


Figure 1. Colcemid-arrested metaphase plate showing a chromatid gap (arrow) in lymphocytes cultured 48 hours in the presence of CPZ.

Table 1. Chromosomal aberrations observed in human lymphocyte cultures following 48-hour exposure to chlorpromazine.

Donor	CPZ Concentration (mcg/ml)	Cells Scored	Chromosome		Chromatid		Polyploid <sup>a</sup> Nuclei
			Gaps	Breaks	Gaps	Breaks	
F-20	0.00	300	0	0	0	1	0
	5.00	250	1	0	2	0	0
	0.50	250	1	0	2	0	1
	0.05	250	0	0	1	0	0
M-22	0.00	300	0	0	0	0	0
	5.00	250	1	0	4	0	1
	0.50	250	0	0	1	0	0
	0.05	250	1	0	0	0	1

a - 200 cells analyzed in each 72-hour control and treated culture.

## Sister chromatid exchanges and chromosomal aberrations

An examination of Table 2 shows that cultures exposed to increasing concentrations of CPZ exhibited dose-dependent growth-arresting effects. These values ranged from a 8.95 percent reduction in the mitotic index of cultures established from the female donor (F-20) and exposed to the lowest concentration to a maximum 67.17 percent reduction in the mitotic index of cultures exposed to the highest concentrations. The inhibitory effect of CPZ on cultures derived from the male donor (M-22) was somewhat smaller. Although the mitotic index observed with the lowest CPZ concentration for cells derived from the male donor (M-22) was not reduced, a similar dose-dependent response of decreasing mitotic divisions with increasing drug concentration was observed.

The means and range of SCE's per cell obtained from treated and untreated cultures are presented in Table 2. Only second division metaphase showing interchanges between sister chromatids (Figure 2) were recorded in the SCE data. The number of SCE's/metaphase in CPZ treated cultures did not differ from the values obtained in untreated controls when the data were evaluated at the 0.05 probability level. Only cells derived from the female donor and exposed to 0.5 mcg/ml showed a slight but significant increase in SCE's when examined at the 0.10 probability level. Cells derived from the male donor revealed a similar pattern of slight to marginal increases in the SCE frequency up to the intermediate concentration, followed by a decrease at the highest concentration to a value that was less than or equal to the SCE frequency in cells exposed to the lowest concentration. The number of induced SCE's/cell/mcg CPZ also showed a similar pattern with values ranging from 0.03 to 2.08.

Table 2. Cellular proliferation and yields of sister chromatid exchanges in human lymphocyte cultures following 72-hour exposure to chlorpromazine.

Donor	CPZ Concentration (mcg/ml)	MI	SCE's per Cell ± S. E.	Range	Induced SCE's per Cell per mcg CPZ
F-20	0.00	6.70	3.61 ± 0.40	0 - 7	
	5.00	2.20	4.12 ± 0.55	0 - 14	0.51
	0.50	5.40	5.69 ± 0.53 <sup>a</sup>	0 - 16	2.08
	0.05	6.10	4.25 ± 0.41	0 - 11	0.64
M-22	0.00	2.30	3.35 ± 0.61	0 - 12	
	5.00	0.90	3.38 ± 0.61	0 - 12	0.03
	0.50	1.20	4.35 ± 0.56	0 - 13	1.00
	0.05	3.20	3.65 ± 0.48	0 - 11	0.30

MI - Mitotic index based on scoring 2000 consecutive mononuclear cells.

a - Significantly different from control cultures ( $p < 0.10$ ). At least 20 metaphases analyzed per donor per treatment.



Figure 2. Colcemid-arrested metaphase from a PHA-stimulated human peripheral blood lymphocyte cultured for two rounds of DNA synthesis in the presence of BrdUrd and 0.5 mcg/ml CPZ. The single exchanges are marked with arrows, exchanges at the centromere are marked with a double arrow.

#### DISCUSSION

The results of the present study revealed that SCE chromosomal aberration responses were remarkably similar in control and treated cultures. This similarity between control and treated cultures indicated that CPZ is not causing DNA lesions that are manifested as changes in chromosome structure. However, exposure of lymphocyte cultures to CPZ is associated with increased mitotic delay and polyploid mitoses. CPZ exhibited little to no growth depressing effects at the lowest concentration but showed cytostatic effects at higher concentrations. A similar pattern of presumptive CPZ toxicity at the higher dose levels was observed by Cohen et al. (1969) in cultured human lymphocytes and Speit and Vogel (1979) in cultured Chinese hamster cells. Levy, Nocentini and Billardon (1983) noted that human fibroblast cultures treated with formaldehyde exhibited an increase in cell ploidy levels as a function of increased culture time similar to the appearance of polyploid nuclei in our 72-hour cultures. The presence of polyploid cells in cultures exposed to CPZ suggests the involvement of spindle apparatus disruptions in the production of increased aberrant mitoses. Finally,



slight differences between the observed responses of cells derived from different donors may reflect intrinsic genetic variations in the ability of donor cells to respond to CPZ assault (Crossen and Morgan, 1982).

It is not clear from these data whether the cytogenetic effects of CPZ are due to a common mode or to several different modes of action. In addition to interacting with DNA (Ohnishi and McConnell, 1969; Jose, 1979), CPZ is known to interact with cellular and nuclear proteins as well as with components of the cell membrane. Gietzen et al. (1980) noted that all processes controlled by the calcium binding protein, calmodulin, are also targets for action by CPZ.

Both structural aberration and SCE rates have previously been evaluated in human lymphocyte cultures treated with CPZ. However, studies correlating CPZ-induced SCE and chromosomal aberration responses for cultures derived from the same individual have not been reported. Our results clearly show that within a given donor one observes similar cytogenetic responses for CPZ activity when each assay is used as an indicator of genotoxicity.

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## Notes

## Notes

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ABSTRACTS

Papers presented at the 64th Annual Meeting  
University of North Alabama  
Florence, Alabama  
March 25-28, 1987

BIOLOGICAL SCIENCES

TYROSINASE ACTIVITY IN HYPERMELANISTIC AND WILD-TYPE SAILFIN MOLLIES.  
Robert A. Angus and William P. Thomas, Biology Dept., University of Alabama at Birmingham, Birmingham, AL 35294.

The "salt and pepper" phenotype of sailfin mollies is a hypermelanistic condition due to the presence of macromelanophores scattered over the body. Previous studies have shown that the macromelanophore pattern is caused by a single temperature-sensitive gene. Penetrance and expressivity of the gene are maximal when fish are raised at cool temperatures (21 C), and minimal when raised at warm temperatures (28 C). A similar situation is found in mammals (Himalayan phenotype) where, due to a temperature-sensitive form of the enzyme tyrosinase, melanin is produced only at cool temperatures. Tyrosinase catalyzes the conversion of tyrosine to DOPA and to DOPA quinone, the first two reactions in the melanin-synthetic pathway. We are presently measuring tyrosinase activity in wild-type and macromelanophore-containing fish at various temperatures to test the hypothesis that hypermelanism in sailfin mollies is due to the presence of a temperature-sensitive enzyme. We have also used the assay to determine that fish of an albino strain of gold sailfin mollies are tyrosinase positive. Although they do not produce melanin in vivo, they are as capable as wild-type fish of doing so in vitro.

PARASITES FROM THE CATTLE EGRET (BUBULCUS IBIS) IN ALABAMA. John R. Porch, Carl F. Dixon, and Julian Dusi, Dept. of Zoology and Wildlife Science, Auburn University, AL 36849.

One hundred ninety Cattle Egrets (Bubulcus ibis) from four areas in Alabama were collected for survey. All birds were inspected for endo- and ectoparasites. Eight species of nematodes, two species each of trematodes, insects, and mites, and one acanthocephalan species were recovered. Parasites were identified as much as possible with existing keys. Infection rates for males and females from all four areas are similar. Parasite load is not concluded to be a reliable indicator of differing migratory pathways.

## Abstracts

### HEMOGLOBIN COMPONENTS IN IRRADIATED RATS OF TWO DIFFERENT STRAINS.

Habiba A. Dowla and Mukul C. Datta, Dept. of Chemistry and Carver Research Foundation, Tuskegee University, AL 36088.

Although no change in hemoglobin (Hb) proportions between normal adults is measurable, the Fischer rat exhibits a significantly higher LD<sub>50</sub>(30) values to whole-body gamma radiation than does the Wistar rat (1050 vs 800 rad) due to a greater marrow resistance in the former. We have compared the effect of radiation exposure on changes in Hb components in these two strains, in an attempt to explore whether any changes in Hb proportions are related to strain radiosensitivity. Both strains were given <sup>60</sup>Co gamma fractions of 400 rad at 0, 16 and 32 days and bled, not exceeding 3 ml each time, at -9 (baseline), 25, 40 and 60 days after the first exposure. Hb components were separated by ion-exchange chromatography using a gradient of NaCl dissolved in glycine-KCN buffer. Hb content, RBC, VPRC, platelets and WBC were all more greatly depressed in the Wistar strain for the samples drawn on 40th and 60th days after the first exposure. Moreover, Hb components I+II+IV in the Wistar rats exhibited a significant switch toward newborn values while the Fischer rats did not.

Days after the first Exposure	Components I+II+IV (Absolute Hb% of total Hb)			
	Fischer-344		Wistar	
	Control	Exposed	Control	Exposed*
40	33.5±1.8 (6)	35.0±3.1 (9)	35.2±3.6 (8)	39.1±3.1 (10)
60	32.2±2.1 (9)	35.5±1.9 (8)	34.3±3.7 (10)	43.7±4.7 (7)

\* significantly changed when compared to Wistar 40 and 60 days controls at p < 0.05 and p < 0.01 respectively. The number in parentheses indicates rat numbers.

We propose that reverse Hb switching may be related to a greater marrow radiosensitivity in the Wistar strain.

PERFORMANCE, PRODUCTION COSTS, AND ECONOMIC RETURNS OF TOMATOES DOUBLE-CROPPED WITH FALL TURNIP GREENS. James E. Brown, Marla C. Osborn, James A. Pitts, and Kenneth C. Short. Department of Horticulture and Chilton Area Horticulture Substation, Alabama Agricultural Experiment Station, Auburn University, AL 36849.

Spring tomatoes and fall turnip greens were double-cropped on a sandy loam soil at the Chilton Area Horticulture Substation, Chilton County, Alabama. Treatments were: 1) spring tomatoes double-cropped with fall turnip greens, 2) tomatoes monocropped, and 3) turnip greens monocropped. Both crops were successfully produced under the double-crop system. Yields of both crops were equal on both cropping system. Production costs to produce two crops under the double-crop system were twice those of either crop grown in monoculture. Total net economic returns of the double-crop system were double those from each crop monocropped. The double-crop system allows the farmer an opportunity to produce two crops a year on the same amount of land needed to grow either crop in monoculture.

REESTABLISHMENT OF PERDIDO KEY AND CHOCTAWHATCHEE BEACH MICE INTO AREAS OF UNOCCUPIED CRITICAL HABITAT. Nicholas R. Holler, and David W. Mason. Alabama Cooperative Fish and Wildlife Research Unit, Auburn University, Alabama 36849.

The Perdido Key beach mouse (Peromyscus polionotus trissyllepsis) and Choctawhatchee beach mouse (P. p. allopshys) are federally classified as endangered. The Perdido Key beach mouse (PK BM) exists only as a remnant population of less than 40 individuals at Florida Point on the west end of Perdido Key. The Choctawhatchee Beach mouse (C BM) occurs as two disjunct populations; one on Shell Island near Panama City, FL, the other on the Topsail Hill area east of Destin, FL. Both populations are substantial; however, the Topsail Hill population is threatened by development. Unoccupied areas of critical habitat exist for both subspecies on publicly owned land, and recovery of the mice would be greatly enhanced if their respective ranges could be significantly expanded into these protected lands. A cooperative relocation program, supported by the Florida Game and Fresh Water Fish Commission, National Park Service, and U.S. Fish and Wildlife Service, has been initiated. Three pairs of PK BM were transferred to a large enclosure on Gulf Islands National Seashore, Perdido Key on 16 Nov 86. An additional pair was transferred to the enclosure on 13 Jan 87. The enclosure was opened on 9 Feb 87; there were earlier escapes and evidence of movement into and out of the enclosure by the mice. Eight pairs of C BM were transferred from Shell Island to Grayton Beach State Recreation Area on 29-30 Jan. These mice were placed into 4 small enclosures which were opened on 31 Jan 87. Observations on 3 Mar 87 revealed an abundance of mouse sign in primary dune habitat at the release site.

EFFECTS OF SOME PESTICIDES ON GROWTH AND NODULATION OF COWPEAS AND PEANUTS. Robert T. Lartey, Dept. of Plant Pathology, Auburn University, AL 36849, Mike Greaves, Long Ashford Research Station, University of Bristol, and C. H. Walker, Dept. of Biochemistry, University of Reading, England.

Experiments were conducted to determine the effects of the insecticide, Undene (propoxur), the herbicide trifluralin, and the fungicide Guazatine on the growth and nodulation of cowpeas and peanuts. Undene was applied as a foliar spray, trifluralin to the soil, and Guazatine as a seed dressing fungicide. There were two assessments for each crop, 18 and 49 days after planting for cowpea and 28 and 50 days for peanut. Assessments were based on root and shoot fresh and dry weights and total leaf area, and percentage nitrogen and nodulation based on number of nodules per root. Only Guazatine showed some initial effects on cowpea, characterized by a delay in growth. There was, however, a slight stimulation in nodulation. Peanut showed initial stimulation of growth and nodulation. However, by 49 and 50 days after planting, no significant differences were observed between Guazatine-treated crops and the control. Undene and trifluralin at the rates applied did not cause any significant effects on growth or nodulation.

THE ROLE OF AN AUXIN ON PEDICEL ABSCISSION OF SOYBEAN, GLYCINE MAX (L.) MERR. N. Suzanne Duchene, Curt M. Peterson, and Roland R. Dute, Dept. of Botany and Microbiology, Ala. Agric. Exp. Stn., Auburn University, AL 36849.

Flower abscission of soybean, Glycine max (L.) Merr., may be controlled, in part, by substances produced in young pods. This study was performed using terminal racemes of field-grown IX93-100 soybean plants to determine whether the auxin, indole-3-acetic acid (IAA), delayed abscission zone formation in soybean pedicels. The distal four flowers of each terminal raceme of field-grown IX93-100 soybeans were excised leaving the pedicels attached to the rachis. Lanolin or lanolin + 500 ppm IAA was applied to the cut end of each pedicel. Similar experiments but using excised racemes on an agar medium in a controlled environment also were performed. In the field studies, auxin delayed the onset of abscission by 24 hr, but all pedicels eventually abscised over a 120 hr period. Three (daily) applications delayed the onset and reduced the extent of pedicel abscission over a 120 hr period. Auxin application to the tip of excised racemes hastened the onset of abscission, but then abscission proceeded similarly to racemes where lanolin was applied to pedicels (controls). In contrast, the pattern of abscission when lanolin + IAA was applied to cut ends of pedicels was similar to those for field experiments. Histological observations revealed no abscission zone in pedicels at time 0. However, after 24 hr, a band of actively dividing cells was evident at the base of lanolin treated pedicels; there was no such band in auxin-treated pedicels. By 48 hr, an abscission zone was evident in both lanolin and lanolin + IAA treated pedicels. These results demonstrate that one or more IAA applications can delay abscission of pedicels from which flowers have been excised.

SEASONAL ACTIVITY AND RELATIVE ABUNDANCE OF SNAKES ON THE UPPER COASTAL PLAIN OF SOUTH CAROLINA. J. Whitfield Gibbons, Savannah River Ecology Laboratory, Aiken, S.C. 29801; Raymond D. Semlitsch, Memphis State University, Memphis, TN. 38152; and David H. Nelson, University of South Alabama, Mobile, AL. 36688

More than 3800 snakes were collected in drift fences with pitfall traps, by road collecting, and by a variety of other methods over a 20-year period on the Savannah River Plant on the Upper Coastal Plain and Sandhills region of South Carolina. They represent 34 of the 38 species known from South Carolina. Tantilla coronata was the most frequently collected species and Carphophis amoenus was the rarest. Species attaining large body size and aquatic snakes (Nerodia) were underrepresented in the sample relative to their actual abundance because of biases in collecting techniques and habitats sampled. More snakes were collected in drift fences with pitfall traps during June and July than in other months despite equal sampling among months. Observations on the life histories of species are presented. The findings emphasize the importance of long-term observations in a region to reveal the presence and abundance of species having secretive behavior, localized populations, or restricted seasonal activity patterns.

TOTAL PROTEIN ANALYSIS OF THE ELEVEN LARVAL DEVELOPMENT STAGES OF THE FRESHWATER PRAWN Macrobrachium rosenbergii BY ISOELECTRIC FOCUSING. Cindi Partain, Hermina J. Cline and George B. Cline. Dept. of Biology, Univ. of Ala. at Birmingham, Birmingham, AL 35294.

Prawn larvae go through 11 developmental stages over 20 to 30 days in 12 ppt sea water before becoming postlarvae (PL). We used our small sample preparation method to separate proteins of single larvae of all stages by IEF in thin layer agarose gels. The pI range was ca. 4 - 7 and silver-stained proteins were scanned with an LKB laser densitometer. Total protein profiles were different for all stages with up to 31 proteins detected per larvae. The majority of proteins of stages 1 - 5 were clustered between pI 4 - 5.7 while proteins of stages 7 - 11 were more evenly distributed between pI 4 - 7. Absolute amounts of some proteins increased expectedly with age and increase in larvae size. Some proteins disappeared with development while new proteins appeared at other isoelectric points. Protein profile variations between cohorts of any given stage show apparent differences in biochemical "ages" which were not apparent in morphological features when stages were selected for analysis. Distinct differences were noted for same stages between stocks. PL tail muscle profiles are different from any larval profiles: they have few proteins below pI 5.3. A new computer system being coupled to the densitometer will permit subtraction of profiles from each other and statistical analysis of appearance/disappearance rates of developmental proteins. This will facilitate identification of stage-specific and stock-specific markers in single larvae and make our approach more widely useful for documenting sources and ages of invertebrate larvae in plankton samples.

PRODUCTION AND ECONOMIC RESULTS OF TOMATOES DOUBLE-CROPPED WITH COLLARD GREENS. Marla C. Osborn, James E. Brown, and Ronnie N. McDaniel, Department of Horticulture and Gulf Coast Substation, Alabama Agricultural Experiment Station, Auburn University, AL 36849.

This study was conducted at the Gulf Coast Substation, Baldwin County, Alabama, on a fine sandy loam soil. Treatments were: 1) spring tomatoes double-cropped with fall collards, 2) collards monocropped, and 3) tomatoes monocropped. The double-crop system was successful. Greater tomato yields were produced on the monocrop system, while similar collard yields were obtained on both systems. Costs to produce both crops under the double-crop system were only slightly higher than the costs to produce the tomato crop in monoculture. Collard production costs were equal on both systems. Total net economic returns from both crops produced under the double-crop system were equal to those of tomatoes monocropped. Monocropped collards resulted in significantly less economic returns than the total returns of both crops double-cropped. The double-crop system reduces the economic risk of monocropping either crop during a year of low market demand for that crop. In addition, this system allows more vegetable production per land unit area.

## Abstracts

SPERM-EGG INTERACTION: EVIDENCE FOR A ZONA PELLUCIDA BINDING SITE ON MURINE SPERM. Richard T. Richardson and Gary R. Poirier, Dept. of Biology, Univ. of Ala. at Birmingham, University Station, Birmingham, AL 35294.

A monoclonal antibody, J-23, was produced to an epitope of a binding (acceptor) site on the plasma membrane in the acrosomal cap region of the mouse sperm head. The site binds a proteinase inhibitor of seminal vesicle origin at ejaculation and participates in the in vitro binding of capacitated sperm to the zona pellucida. The antibody, an IgM molecule recognizes affinity purified acceptor, crude acceptor and whole sperm as determined by ELISA methodology. The antibody reacts with a 15,000 molecular weight component, the size previously determined for the acceptor, found in the supernatants of frozen-thawed cauda epididymal sperm. In addition, it binds to a 21,000 molecular weight component generated by mixing an excess of purified inhibitor (6,400 daltons) with a crude acceptor preparation. J-23 binds to an epitope in the same region of the sperm head as does the inhibitor. This epitope becomes fully expressed during epididymal maturation and is found only in the lumen of epididymal tissues. Pretreating sperm with J-23 inhibits their ability to bind the inhibitor as well as the zona pellucida. Pretreating sperm with the inhibitor has little effect on the binding of J-23. These data indicate that J-23 recognizes an epitope on the acceptor but the epitope is not directly involved with inhibitor binding.

ECONOMICS OF DOUBLE-CROPPING SOUTHERNPEAS WITH FALL BROCCOLI IN SOUTH ALABAMA. James E. Brown, Marla C. Osborn, and Ronnie N. McDaniel, Department of Horticulture and Gulf Coast Substation, Alabama Agricultural Experiment Station, Auburn University, AL 36849.

Spring southernpeas were double-cropped with fall broccoli on a fine sandy loam soil at the Gulf Coast Substation, Baldwin County, Alabama. Treatments were as follows: 1) spring southernpeas double-cropped with fall broccoli, 2) spring southernpeas monocropped, and 3) fall broccoli monocropped. Southernpeas and fall broccoli produced equal yields on both systems. Total production cost to produce both crops under the double-crop system was twice the cost to produce either crop in monoculture. Length of harvest periods for both crops was equal on both cropping systems. Total net economic returns from both crops double-cropped were twice the returns of either crop monocropped. The double-crop system allows the operator an opportunity to produce a second crop during a growing season on the same land unit area as the preceding crop. Under conditions where the market value of one crop grown in monoculture is depressed, the double-crop system would be an advantage.

A SAMPLE PREPARATION METHOD FOR ANALYZING SMALL SINGLE INVERTEBRATE LARVAE BY ISOELECTRIC FOCUSING. George B. Cline, Cindi Partain and Charles W. Hardwick, Jr., Dept. of Biology, Univ. of Ala. at Birmingham, Birmingham, Al 35294.

Most early-stage invertebrate larvae are microscopic and are difficult to prepare for analysis by electrophoretic methods. We report a method for preparing individual larvae as small as newly hatched brine shrimp nauplii (1.5 ug) for analysis by IEF and show that at least two analyses can be made on a single larvae. We also report a method for partial molecular weight fractionation of these samples before IEF separation. We used the brine shrimp Artemia salina and the fresh water prawn Macrobrachium rosenbergii. Smallest larvae are immobilized alive in small folded "wicks" (ca 2 x 4 mm) of Whatman filter paper while larger larvae (e.g. prawn stages 6 - 11 and postlarvae) are prepared in 3 x 6 mm or larger wicks. A wick is folded with a single larvae inside and crushed between two glass surfaces. Wick sizes are matched to larvae sizes to absorb all juices released with the crush. Wicks are put into small sealed plastic capsules and frozen and thawed 3X in liquid nitrogen. For two analyses on one sample, the wick is cut at the fold into top and bottom parts and each is analyzed separately. Proteins are silver stained and isozymes are visualized by tetrazolium-coupled reactions. For mol. wt. separations, a new wick is placed on a clean plastic surface with a piece of Gelman mol. wt. filter (e.g., 50 K cutoff) over it and a larvae sample wick layered on top. A measured drop of buffer to the top is absorbed through the stack before the sample wick, filter and bottom wick are analyzed by IEF. Multiple filters of different cutoffs are used if additional fractionation is needed.

ECONOMICS AND PRODUCTION COSTS OF SPRING EGGPLANTS DOUBLE-CROPPED WITH FALL MUSTARD GREENS. James E. Brown, Marla C. Osborn, James A. Pitts, and Kenneth C. Short, Department of Horticulture and Chilton Area Horticulture Substation, Alabama Agricultural Experiment Station, Auburn University, AL 36849.

The performance and productivity of eggplant and mustard greens were evaluated at the Chilton Area Horticulture Substation, Chilton County, Alabama, on a sandy loam soil. Treatments were: 1) spring eggplant double-cropped with fall mustard greens, 2) spring eggplant grown in monoculture, and 3) mustard greens produced in monoculture. Both crops were successfully produced under the double-crop system. Yields of eggplant and mustard were equal on both crops on both systems. Production costs to produce both crops under the double-crop system were double those of either crop grown in monoculture. Total net economic returns from the double-crop system were twice the returns of either crop monocropped. The double-crop system allows the grower an alternative of vegetable production practice. This system also reduces the economic risk of producing either crop alone during a year of low market demand for that crop.

## Abstracts

DYNAMICS OF AN ALABAMA PINE VOLE POPULATION. Thomas V. Fleming and Ronald D. Gettinger, Department of Biology, University of Alabama at Birmingham, University Station, Birmingham, AL 35294.

As part of an investigation of seasonal reproduction and thermoregulation, we have undertaken a mark/release study to provide information on the population dynamics of the pine vole, Microtus pinetorum. A permanent 10 x 10 meter trapping grid was established in old field habitat in St. Clair County, Alabama. Each month, beginning in June, 1986, small mammal abundance has been assessed on this grid. In addition to the pine vole, four other rodent species and one species of shrew have been captured. Relative abundance has ranged from 12.6 voles/100 trapnights to 27.1 voles/100 trapnights. These figures exceed those reported for voles in apple orchards which are considered prime vole habitat. Some portion of the population has been reproductively active each month though no pattern is yet clear. Generally, a larger proportion of females are reproductively active (range 11.8% to 76.5%) than males (range 5.0% to 50.0%). However, sex ratios (male to female) have favored males ranging from 0.87 to 1.88. Each month, reproductive organs were collected from a sample of adult animals. Mean paired testes weights ranged from 1.95 mg/g body weight to 5.03 mg/g and mean paired ovarian weights ranged from 0.14 mg/g to 0.40 mg/g. There was no seasonal pattern apparent in paired testes weights. Ovarian weights appeared to decrease during the winter. Pregnant females were present during each month except March, 1987. Post-mortem examination revealed an average embryo count of  $2.0 \pm 0.5$ . Mean body mass varied from 20.3g in August, 1986 to 23.9g in January, 1987.

NEW PLANT DISTRIBUTION RECORDS FOR THE REDHILLS OF ALABAMA. Alvin Diamond, Jr., and John D. Freeman, Dept. of Botany and Microbiology, Auburn University, AL 36849.

During the period from March of 1985 to January of 1987, while conducting field work for "A Flora of the Mesic Ravines of the Red Hills of Alabama", a number of new county distribution records were obtained. These represent new county records as well as range extensions. Among the most interesting of these are: Rhododendron alabamense, Isopyrum biternatum, Aquilegia canadensis, Pteris multifida, a yellow flowered form of Calycanthus floridus, Isoetes engelmannii and Lycopodium cernuum for Conecuh County; Dryopteris celsa, and Rhododendron minus for Monroe County; Trillium lancifolium for Wilcox County; Medeola virginiana and Anemone berlandieri for Conecuh and Butler counties; Salix eriocephala for Conecuh, Butler, Monroe, Crenshaw, Pike and Bullock counties; and Trillium catesbaei for Conecuh and Pike counties. Some of these species show phyto-geographic affinity with the flora of the Appalachian Mountains and others with the flora of the Great Plains region.



EVOLUTIONARY RELATIONSHIPS OF THE BOARFISHES. Steven J. Zehren, Dept. of Cell Biology and Anatomy, Univ. of Ala. at B'ham, B'ham, AL 35294.

The boarfishes (Family Caproidae) are a group of marine teleosts comprising two genera, Capros and Antigonia. A comparative osteological study was made to determine the evolutionary relationships among the species of Antigonia. For each osteological character used the primitive vs. derived state was ascertained by outgroup analysis. Only the common possession of derived states among species was considered evidence of evolutionary relationship. The following groups can be recognized on the basis of shared derived states: 1) A. eos + A. capros possess 31 or more dorsal and 29 or more anal rays 2) A. combatia + A. malayana have 13 pectoral rays (this feature is not unique to them, however) 3) A. eos + A. capros + A. combatia + A. malayana possess 4 dorsal procurent caudal rays 4) A. rubescens + A. rubicunda possess 2 ventral procurent caudal rays 5) A. rubescens + A. rubicunda + A. rhomboidea also have 13 pectoral rays and 6) all 7 species of Antigonia share 16 derived states, including the presence of a protuberance on the interopercle which fits into a notch on the epihyal, a mesethmoid that is ring-shaped dorsally, and scales which have a large ridge that is bent posteriorly, aligned dorsoventrally and denticulated on the margin. A. eos is unique in having only 0-1 predorsal bones, A. rhomboidea in having the alveolar process of the premaxilla distinctly notched, and A. malayana in having an indistinct flange on the maxillary shaft and only 2 pores in the dentary for the mandibular lateral line.

GROWTH AND DEVELOPMENT OF BACHMAN'S SPARROW (AIMOPHILA AESTIVALIS) NESTLINGS. Thomas M. Haggerty and Damien Simbeck, University of North Alabama, Florence, AL 35630.

The growth and development of Bachman's Sparrow (Aimophila aestivalis) nestlings were studied in central Arkansas during 1983-1985. The nestling period lasted between 8-9 days (mode = 8.5 days). On fledging day, tarsus, wing, bill, and tail lengths were 99%, 70%, 53%, and 11% of the mean adult length, respectively. The overall tarsus and mass growth rate constants were  $0.44 \pm 0.07$  [95% CI] and  $0.50 \pm 0.12$ , respectively. No difference in weight gain or tarsus growth was found between small broods and large broods, between early and late season broods or between "old field" and "pine forest" broods. However, nestlings raised in 1984 attained a greater mean mass and tarsus length by Day 5 than nestlings raised in 1983 or 1985 and gained weight at a faster rate than those nestlings raised in 1985. Variation between years might be attributable to lower temperatures and higher precipitation levels of the 1984 breeding season. Results show that Bachman's Sparrow nestlings develop and grow at rates similar to those of closely related sparrows.

<sup>125</sup>I-EPIDERMAL GROWTH FACTOR BINDING TO RAT HEPATOCYTE NUCLEI. Debra M. Moriarity, Toni Underwood and Julie Maupin, Dept. of Biological Sciences, University of Alabama in Huntsville, Huntsville, AL 35899.

Epidermal growth factor (EGF) has been shown to be a potent mitogen for many different cell and tissue types including liver. Despite considerable effort by many laboratories its precise mechanism of action is not yet known. Cell surface receptors for the growth factor have been identified on responsive cells and are quite probably involved in mediating the effects of EGF on target tissues. These receptors have been shown to possess tyrosine kinase activity and to be internalized into the cell along with the bound EGF after the initial interaction between the growth factor and the cell. The role of the internalization of bound EGF and its receptor is not clear, but may indicate a possible intracellular role for the growth factor and/or its receptor during stimulation of a target cell. This hypothesis has gained support from studies showing that EGF binds specifically to isolated adult rat liver nuclei. We have investigated the interaction of <sup>125</sup>I-EGF with isolated liver nuclei and have found specific, high affinity binding sites for EGF. Further subfractionation of the nuclei has indicated that EGF bound by the nuclei is present in the nucleoplasm, the inner nuclear membrane and in the chromatin fractions. Initial experiments also have indicated that <sup>125</sup>I-EGF is internalized by primary cultures of adult rat hepatocytes and may accumulate in the nuclei after 24 hours. We are currently extending these studies to examine the physiological significance of the interaction of EGF with the hepatocyte nuclei.

MECHANISMS IN THE BIOLOGICAL CONTROL OF RHIZOCTONIA SOLANI BY A MYCOPHAGOUS COLLEMBOLAN INSECT AND ANTAGONISTIC FUNGI. Robert T. Lartey, E. A. Curl, and Curt M. Peterson, Dept. of Plant Pathology and Dept. of Botany and Microbiology, Alabama Agricultural Experiment Station, Auburn University, AL 36849.

More effective biological control of plant-root diseases is being sought by employing combinations of biocontrol agents. In greenhouse experiments, Proisotoma minuta (Insecta: Collembola) and each of three fungal biocontrol agents, Gliocladium virens, Trichoderma harzianum and Laetisaria arvalis, effectively reduced severity of cotton seedling disease caused by Rhizoctonia solani. Combined application of the insect and each fungal agent provided a control benefit greater than with either agent used alone. The insects, in populations of 100 or more per petri dish, grazed and rapidly destroyed 50-mm diameter colonies of R. solani on a cultural medium. The insects were more attracted to the pathogen than to the fungal agents when exposed to the pathogen and the fungal agents together. The fungi inhibited the growth of R. solani in standard antibiosis tests. Microscopic observations revealed that all three fungal agents parasitized the pathogen. Thus, biological control of the pathogen and the disease by combinations of the insect and fungal agents is attributed to destructive feeding by the insect along with parasitism of the pathogen by the fungal agents.

ZOOPLANKTON GRAZING IMPACT ON SHORT-TERM CHANGES IN CHLOROPHYLL A CONCENTRATION IN ESTUARINE WATERS. Donald E. Stearns, Dauphin Island Sea Lab, P.O. Box 369-370, Dauphin Island, AL 36528. Wayne Litaker, Dept. of Microbiology and Immunology, Univ. of North Carolina, Chapel Hill, NC 27514. Gene Rosenberg, Botany Dept., Univ. of Georgia, Athens, GA 30602.

Four summer field studies lasting 31 to 48 h were completed near the mouth of the Newport River estuary, Beaufort, North Carolina. Short-interval (1-3 h) sampling revealed a distinct diel change in chlorophyll a concentration, with an afternoon peak followed by a decline beginning well before sunset, regardless of tides, rainfall or runoff. During one study, abundances at three depths (surface, 1.5 m, 6.5 cm above the 1.8 to 2.8 m bottom) and in situ measurements of gut fullness of adult Acartia tonsa, a common phytoplanktivorous copepod, were taken simultaneously with chlorophyll a samples. Later, copepod gut clearance time was measured at field temperature. Using these data and making mainly maximizing assumptions, we estimated that grazing by all postnaupliar copepods  $>75\ \mu\text{m}$  explained about 9% of the decline in ambient chlorophyll in the afternoon, 19% at night. About 20% of the daily net primary production was grazed by the postnaupliar copepod community. These results indicate that postnaupliar copepods play a minor role in summer grazing losses in this well-mixed estuary. Our results underscore the importance of (1) measuring in situ grazing rates with minimal handling under natural conditions and (2) considering temporal variations in grazing rates when designing sampling regimes to determine grazing impact.

A STUDY OF STERIC SPECIFICITY WITH THE N-ARYLSULFONYLGLYCINE ALDOSE REDUCTASE INHIBITORS. Charles A. Mayfield and Jack DeRuiter, Department of Pharmacal Sciences, School of Pharmacy, Auburn University, AL 36849.

A number of N-arylsulfonylamino acids which possess the basic structural features required for aldose reductase inhibitory activity were synthesized and tested for their ability to inhibit aldose reductase obtained from rat lens. In this assay the N-arylsulfonylglycines are significantly more potent as inhibitors than the corresponding alanine derivatives, and the alanines are more potent than the corresponding proline analogues. Also, in the glycine series it was observed that addition of substituents to the N-aryl moiety can profoundly influence inhibitory potency. For example, the  $\beta$ -naphthyl- and N-[4-(benzoylamino)benzenesulfonyl]glycines are the most potent inhibitors of this structural class, producing 50% enzyme inhibition at concentrations of  $0.4\ \mu\text{M}$ . To further explore the influence of varying structure on activity in this series of compounds, a number of derivatives of the N-arylsulfonylglycines were prepared in which substituents of different steric nature were incorporated at the methylene carbon, the sulfonamide nitrogen and the N-aryl moiety. From evaluation of this series of derivatives, and determination of relative inhibitory potencies, it is possible to determine the steric specificity of the enzyme for inhibitors of this structural class.

## Abstracts

PERIPHYTON PRODUCTION AND ABSORPTION EFFICIENCIES AND RATES OF FEEDING OF A GRAZING SNAIL. Jacqueline M. Lane, Dept. of Science, Pensacola Junior College, 5555 W. Highway 98, Pensacola, Florida 32507.

Caloric production of periphyton, and rates of feeding and caloric absorption efficiencies for a grazing snail were measured monthly for a year in the field to test the hypothesis that snails try to maintain a constancy of energy intake in a changing natural environment.

Glass plates were placed in the water for 26 days and microalgae allowed to grow on them. Snails, Neeritina reclinata, were then introduced to the glass plates and rates of feeding and absorption efficiencies were measured.

Production (increase in dry weight on glass plates) was highest in summer and fell twenty-fold in the winter. Diatoms were the main component of plate-grown material in all seasons. Carbohydrates and lipid were the most abundant biochemical components of the periphyton in May (21% of dry weight) and December (24% of dry weight) respectively and varied inversely. Protein levels varied from 7% dry weight in December to 4% dry weight in May. Caloric levels were highest in winter months (2.7 kcal.g<sup>-1</sup> dry periphyton or 5.7 kcal.g<sup>-1</sup> AFDW) and lowest in July (1.0 kcal.g<sup>-1</sup> dry periphyton or 2.2 kcal.g<sup>-1</sup> AFDW).

Rates of feeding were generally highest during warm months. Animals did not feed when water temperature dropped below 10°C. Increase in feeding rate in spring produced a  $Q_{10}$  of 12. The slope of log feeding rate.g dry weight<sup>-1</sup> versus log animal weight = -0.93, indicating small animals ate nearly as much as large animals.

Absorption efficiencies ranged from 5% in November to 65% in May. No significant correlation was found between caloric content of food, rates of ingestion, absorption efficiencies or food production. There was a significant positive relationship between temperature and food production.

OVIDUCTAL MORPHOLOGY AND SPERM STORAGE IN THE KEELED EARLESS LIZARD, HOLBROOKIA PROPINQUA. Caroline S. Adams and William E. Cooper, Jr., Biology Dept., Auburn Univ. at Montg., Montgomery, AL 36193.

Oviductal anatomy of H. propinqua is described. The anterior and middle vagina have transverse folds between which sperm are stored. Sperm are also stored in sac-like seminal receptacles which appear to be formed by twisting of the folds in the anterior vagina. These seminal receptacles are located between the vaginal epithelium and circular muscle. In the posterior vagina are longitudinal folds which do not store sperm. In the crypts of the middle and anterior vagina sperm heads are oriented perpendicularly to and penetrate the epithelium in areas having a well-developed ciliary border. Sperm were stored in seminal receptacles throughout the 78 day observation period, but the number of sperm stored decreased significantly during the latter part of the study. Some captive females produced new clutches of eggs in the absence of males, indicating a potential for use of stored sperm. Large numbers of sperm occurred in the vaginas of freshly captured females having large preovulatory follicles, suggesting that mating frequently occurs shortly before ovulation.

Key words: Sperm storage; oviduct; copulation; coloration; Reptilia; Lacertilia; Iguanidae; Holbrookia

## Abstracts

EFFECTS OF DIET AND COLD STRESS ON LEAD-DOSED CAPTIVE FEMALE MOURNING DOVES. Carolyn M. Marn, Ralph E. Mirarchi, and Michael E. Lisano. Dept. of Zoology and Wildlife Science, Auburn Univ., Auburn, AL 36849.

The effects of diet and cold stress on captive female mourning doves (Zenaida macroura) dosed with lead (Pb) shot were investigated from 12 December 1985 to 2 January 1986. A 2x2x2 factorial design was used with Pb (1 #8 shot [70 + 0.5 mg] or seed), diet (commercial pelleted ration or mixed seed-corn), and temperature (5C or 22C) as the factors of interest. Ninety-six doves were assigned randomly to 1 of the 8 treatments. No mortality occurred and changes in body weight did not differ ( $P>0.05$ ) between Pb-dosed doves and controls. Eroded shot were recovered from 91% of Pb-dosed doves, and 98% of recovered shot were eliminated in the feces. Doves on the pelleted diet retained shot longer ( $P<0.05$ ) and eroded more ( $P<0.05$ ) Pb than did doves on the mixed seed diet. Femur, kidney, and liver Pb levels were higher ( $P<0.05$ ) in Pb-dosed doves. Among Pb-treated doves, tissue Pb levels were higher ( $P<0.05$ ) in birds on the mixed seed diet. The increased likelihood of shot elimination on the mixed seed diet was apparently offset by nutritional and/or other factors which increased Pb retention in body tissues. Pb toxicosis in mourning doves is complex because Pb, diet, and environmental factors may interact to affect Pb metabolism, enhancing or reducing potential toxic effects. In wild mourning doves, susceptibility to the effects of Pb ingestion will depend primarily upon dietary composition, amount of Pb ingested, and frequency of Pb ingestion. (Supported by Ala. Agric. Expt. Station Project No. 13-0065).

COMPARISON OF CERTAIN XYLOSE-FERMENTING YEASTS FOR PRODUCTION OF ETHANOL. Chiquita Baker and Mary J. Beck, Tennessee Valley Authority, Research Division, Muscle Shoals, AL 35660.

Hemicellulosic sugars represent about one-fourth of the dry weight of hardwoods. These sugars can be important feedstocks for the production of ethanol. The Tennessee Valley Authority is capitalizing on the fermentation of hemicellulosic sugars as well as the fermentation of the more conventional cellulosic sugar glucose to make an economically favorable ethanol from hardwood process. In TVA's process sugar production comes from a two-stage dilute acid hydrolysis. The first stage yields a xylose-rich sugar stream while the second stage yields a glucose-rich stream. Fermentation of each stream is made difficult because of the nature of wood and the sugar production techniques. In spite of this, yeasts which ferment glucose can be applied to achieve near-theoretical ethanol yields. Xylose-fermenting yeasts are less productive and present a challenge in conversion of xylose to ethanol. A number of strains of xylose-fermenting yeasts, including strains of Pachysolen tannophilus, Candida shehatae, and Pichia stipitis, are known. This presentation will include a comparison of the growth, xylose consumption, and ethanol production of twenty strains of these yeasts in hemicellulosic hydrolyzates of hardwood. A comparison of the performance of each strain in a synthetic medium, having the same sugar composition as hydrolyzate but lacking inhibitors, will also be made.

VITELLOGENIN DEGRADATION IN THE CRICKET EMBRYO. Holley L. Handley and James T. Bradley, Dept. of Zoology and Wildlife Sciences, Auburn University, AL 36849.

During insect vitellogenesis, vitellogenin in the hemolymph is taken up endocytically by growing follicles to form vitellin (VN)-containing yolk spheres. Insect VNs are multisubunit phospholipoglycoproteins presumed to function primarily as a source of nutrients during embryogenesis. Little is known of the mechanism(s) whereby these molecules are metabolized by the developing egg. The objective of this study was to identify and partially characterize degradation products of yolk polypeptides in the cricket, *Acheta domesticus*. Fertilized eggs were collected just after oviposition and incubated in moist sand at 27-30°C. Twelve to 15 embryos were isolated every 12-24 hours after oviposition until hatching which occurred on about day 15. Groups of embryos from each developmental period were homogenized in a buffer containing 2mM PMSF, and the soluble egg polypeptides were separated by SDS-polyacrylamide gradient gel electrophoresis. Polypeptide patterns were visualized with Coomassie blue, silver, or by Western blotting using a VN-specific antiserum. Five major stage-specific VN degradation products (DP 1-5) with molecular weights ranging from 38 to 188 kD were identified. The levels of DP 1-5 increased while the levels of intact VN polypeptides decreased in the egg during development. Future work will focus on mechanisms regulating VN metabolism in the insect embryo. (Supported by HATCH Project 665, Ala. Agric. Experiment Station)

GENETIC DIVERGENCE OF INTRODUCED MOSQUITO FISH POPULATIONS IN HAWAII. Michael C. Wooten, Dept. of Zoology, Auburn Univ., Auburn, AL 36849. Kim T. Scribner, Savannah River Ecology Laboratory, Drawer E, Aiken, SC 29801.

Mosquitofish, *Gambusia affinis*, were reportedly introduced from Texas into Hawaii in 1905 as an aid in malaria vector control. Since this time, mosquitofish populations have been successfully established throughout this region. For this study, populations of mosquitofish were collected in 17 reservoirs from three islands in Hawaii and from three populations at or near the original Texas source location. Electrophoretic and morphological analyses were conducted to determine the amount and direction of evolutionary divergence in the island populations. Electrophoretic variability for each fish was determined by screening of 28 putative gene loci. Populations of Hawaiian mosquitofish exhibited high levels of genetic variability with several populations having substantially diverged from the founding stocks. Significant variation in life history and genetic characteristics was also found between fish stocks collected from reservoirs characterized as stable and fluctuating based on degree of water level fluctuation. High levels of genetic variation, lack of common allele fixation and significant correlations to water quality parameters argue against purely stochastic explanations for observed population divergence. Possible causal evolutionary models will be discussed based on the observed data.

## Abstracts

POTENTIAL FOR GLUCOSE PRODUCTION THROUGH ENZYMATIC HYDROLYSIS OF HARDWOOD. Robert Johnson and Mary J. Beck, Tennessee Valley Authority, Research Division, Muscle Shoals, AL 35660.

The Tennessee Valley Authority is involved in research and development of processes for the conversion of hardwoods to sugars for subsequent fermentation to ethanol. An acid process, in comparison to an enzymatic process, is characterized by faster conversion time and lower conversion efficiency. An acid hydrolysis process has the disadvantage of producing sugar degradation products too. Likewise, an enzymatic process has disadvantages in comparison to an acid process. The time needed for conversion of hardwoods to sugars by the cellulase complex of the fungus Trichoderma reesei is measured in hours and days as compared to minutes for the acid catalyst. An increased cellulase complex concentration is critical in reducing the time requirement. The substrate used for growing the fungus and producing the enzyme complex needs to be less expensive also. The use of hardwood cellulose as an enzyme induction substrate instead of purified cellulose preparations would greatly benefit a process. Pretreatments to the wood to increase enzyme accessibility are necessary. A dilute acid prehydrolysis can effectively remove hemicellulose materials and alter hardwood chip gross structure allowing access to the cellulosic component of the wood. This presentation will highlight research in the areas mentioned and in finding the best fungal enzyme complex for use with hardwood, optimizing enzyme production on hardwood, reducing hardwood saccharification time, and exploring the potential for enzyme recovery and recycling.

CAMEL CRICKET VITELLOGENIN HAS AN UNEXPECTED STRUCTURE. James T. Bradley, Karen Koon Kerle, and Karen G. Wolfe, Dept. of Zoology and Wildlife Sciences, Auburn University, AL 36849.

Vitellogenin (VG) is the blood borne precursor to egg yolk protein. It is produced by the insect fat body and undergoes extensive post-translational processing prior to its secretion into the hemolymph. In most insects VG is a multisubunit protein comprised of large (140-180kD) and small (45-60kD) polypeptides. An evolutionary model for insect VGs (J. Mol. Evol. 18:405, '82) proposes that the two size classes of VG subunits represent distinct polypeptide domains and are derived from asymmetric cleavage of large primary translation products. Our objective was to identify VG in *Ceuthophilus* sp., a camel cricket native to Alabama, and analyze its structure in the context of this model. By native and SDS-PAGE, VG was identified on the basis of its sex and stage specificity and its kinetics of uptake from the hemolymph. All four VG polypeptides (FSYP I-IV) became labeled with [35S]-met after 1 hour of *in vivo* incorporation and appeared inside vitellogenic follicles after 2 h of incorporation. Unlike the cricket, *Acheta domesticus*, that has two native VGs, *Ceuthophilus* has a single, native VG with subunit molecular weights of 83-165kD. We propose that the FSYPs are derived by the symmetric cleavage of two large precursor polypeptides. Further study of VG in this species may provide insight into the dynamics of VG gene evolution. (Supported by HATCH Project 665, Ala. Agricul. Experiment Station)

STRUCTURE AND CHARACTERIZATION OF THE 3' END OF BOVINE MYOSIN HEAVY CHAIN GENES. James R. Hudson, Jr., Holly E. Richter and Ronald B. Young, University of Alabama in Huntsville, Huntsville, AL 35899

Myosin is the major sarcomeric protein found in the contractile apparatus. It is composed of two 200K dalton heavy chains and two pairs of low molecular weight light chains. Myosin heavy chain (MHC) determines myosin ATPase activity which correlates with the contractile activity of muscle and therefore is an integral protein of muscle contraction. Myosin heavy chain has been found to be encoded by a multigene family in cattle. The strong possibility therefore exists that MHC isoform expression is differentially regulated in cattle in terms of tissue and developmental stage appearance. Seven unique genomic clones have been isolated from a Charon 28 library utilizing a 3' end specific MHC cDNA probe. These clones have been characterized by restriction enzyme analyses and have an average insert size of 14 kb. Many of the protein domains in MHC have been found to be homologous in sequence among species. DNA regions do exist however, at both the 5' and 3' ends of the gene which diverge in sequence and thus can be utilized as isoform specific probes. Fragments from the 3' untranslated region of each clone have been isolated and have been shown to be specific by demonstrating that under stringent conditions each fragment only hybridizes to the clone it was isolated from. In order to more fully characterize these fragments they are being used as probes for hybridization to RNA isolated from several bovine fetal, neonatal and adult tissues. This work was supported in part by grants from USDA, Nitt and American Cyanamid.

BIOGENIC AMINES: METABOLIC PATHWAYS IN THE THREADWORM, TRICHOSTRONGYLUS COLUBRIFORMIS. John C. Frandsen and Leon W. Bone, U.S.D.A., A.R.S., Animal Parasite Research Lab., Auburn, AL 36831-0952.

In vitro metabolic pathways for histamine (HIS), epinephrine (EN), norepinephrine (NE), and octopamine (OC) in Trichostrongylus colubriformis were studied using radioactive tracers introduced into homogenates of mixed sexes of adults. After incubation, extracts of the homogenates were injected into HPLC columns, and the UV absorbances and radioactivities of the fractions collected were monitored to identify the active peaks. The identities of metabolites in the eluate were obtained by comparison with the elution profiles of authentic standards. Vanillylmandelic acid (VMA), 4-hydroxy-3-methoxyphenyl glycol (HMPG) and metanephrine (MN) were formed from EN; VMA, HMPG and normetanephrine (NMN) from NE. Inhibitors of monoamine oxidase (MAO) and catechol-O-methyltransferase (COMT) reduced the rate of formation of VMA. COMT inhibitor reduced the formation of HMPG from NE, but not from EN; this inhibitor did not reduce the amount of MN formed from EN. NE, synephrine and EN were formed from OC, presumably by hydroxylation and methylation as in mammals. With inhibitors of phenylethanolamine-N-methyltransferase and COMT, OC was deaminated, with production of p-hydroxymandelic acid and NE. NE was not converted to NMN in the presence of a COMT inhibitor. Imidazole-4-acetic acid, 1,4-methylimidazole acetic acid and acetylhistamine were formed from HIS. Such acetylation of HIS rarely, if ever, occurs in mammals.



ERYNIA DELPHACIS (ZYGOMYCETES: ENTOMOPHTHORALES), A NEWLY DISCOVERED PATHOGEN OF THE THREECORNERED ALFALFA HOPPER, SPISSISTILUS FESTINUS (SAY). Melissa K. Miller and James D. Harper, Dept. of Entomology, Auburn University, AL 36849.

The threecornered alfalfa hopper, Spissistilus festinus (Say) (Homoptera: Membracidae), is a pest of soybean in the southeastern U.S. It causes damage by feeding on the phloem of soybean plants, resulting in reduced nutrient translocation, petiole and mainstem girdling, and often mainstem lodging. A study was initiated in 1985 to determine the natural mortality factors affecting S. festinus in Alabama soybean fields. An entomopathogenic fungus previously unknown from North America was found infecting adult and nymphal S. festinus. This fungus, Erynia delphacis (Hori) Humber, was the most important natural mortality factor identified in our study plots. Epizootics of E. delphacis were recorded in both 1985 and 1986 from two geographic regions of the state. They appeared to be correlated with high rainfall, humidity, and host density as well as canopy closure. In one field where these criteria were not met in 1986, no epizootic occurred even though the fungus had been present in the previous year. Erynia delphacis was readily isolated and cultured in the laboratory. Both field collected and cultured inocula proved highly virulent in laboratory bioassays. These studies suggest that this fungus is an excellent candidate for biological control of the threecornered alfalfa hopper in soybean fields.

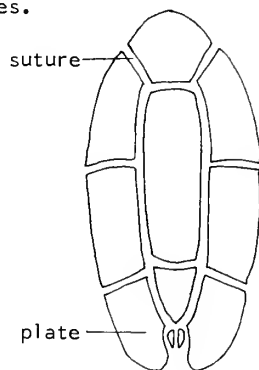
OUTBREAK OF TOMATO SPOTTED WILT VIRUS IN ALABAMA. R. T. Gudauskas, A. K. Hagan, W. S. Gazaway, J. M. Mullen, Dept. of Plant Pathology, and J. R. Weeks, Dept. of Entomology, Ala. Agric. Exper. Sta. and Ala. Coop. Extension Ser., Auburn Univ., AL 36849.

An outbreak of tomato spotted wilt virus (TSWV) occurred in tomatoes, peanuts, and some other crops in Alabama in 1986. Although general incidence of TSWV was low, there were some instances of heavy losses to the virus in major tomato and peanut production areas. Symptoms of TSWV infection in tomatoes included mottling of leaves accompanied by necrotic spotting, veinal necrosis, and bronzing, followed by general blighting and death of upper plant parts. Dark colored streaks often developed on petioles and stems, and chlorotic and/or necrotic rings sometimes appeared on fruit. In peanuts, symptoms ranged from chlorotic ringspotting and mottling of foliage and shortening of terminal internodes, to severe stunting of plants, reduced pod set, and seed coat mottling. Some TSWV-infected peanut plants showed a rapid decline in vigor characterized by a general yellowing, collapse of limbs, and ultimately death of the entire plant. TSWV-infected peanut plants were found in 51 of 54 fields surveyed in the nine major peanut-producing counties. Tomato plantings were not surveyed; however, TSWV was diagnosed in samples received at the Plant Diagnostic Laboratory from 34 counties throughout the state. The outbreak of TSWV in Alabama presumably was related to increased incidence of the virus in nearby states and heavy infestations of thrips, the insect vectors of TSWV, throughout the state in 1986.

IDENTIFICATION OF SOFT SCALE INSECTS (HOMOPTERA: COCCIDAE) UTILIZING CHARACTERISTICS OF THE MALE PUPAL COVER. Gary L. Miller and Michael L. Williams, Department of Entomology, Auburn University, AL 36849

Scale insect (Homoptera: Coccidae) identification is based primarily on adult female characters. Recently, workers have begun to utilize the immature stages and adult males as additional diagnostic tools. Use of adult males in classification schemes has been limited because they are small, short-lived, difficult to collect, and often unavailable because not all coccids produce males.

Second instar males secrete a protective wax covering called a test, which shields the developing male through the prepupal, pupal and early adult stages. Tests usually remain attached to the host plant after the adult has emerged. These tests can easily be collected and preserved. A generalized male test contains 8 basic sutures and 10 corresponding plates (see figure on right). Tests range from simple to highly ornate and possess a varying degree of sutures and plates. Composition of wax in the test may differ among species. This test variability is useful for species determination and provides a means for species identification in the field.



Generalized  
male test

TWINNING: A BIOSOCIAL MECHANISM OF POPULATION REGULATION IN HUMANS?  
Janet P. Abbott-King, 144 Fuller St., Auburn, AL 36830

Problematic demography of twinning includes high twinning rates (HTRs) among large families, post-war births, and rural and island populations. This paper suggests an original hypothesis to account in part for some unexplained patterns of twinning observed in human populations and to serve as an alternative focal-point for research into human population regulation. Necessary assumptions are that 1) social structures (i.e., religion and culture), perception of population density, and wartime mortality are sources of emotional/cognitive impact ("stress") which might affect ovarian function by altering hypothalamic, pituitary, and adrenal neurosecretory activity with regard to catecholamines, opioid peptides, GnRH-pulse frequency and amplitude, and FSH/LH release, thereby promoting multiple ovulation, and 2) stress is defined to include positive effects (enhancing reproductive potential, e.g., multiple ovulation) as well as negative effects (inhibiting reproductive potential, e.g., anovulation). The common denominator of a reproductive imperative due to social, religious and cultural parameters is discussed with regard to Yoruba, Hispanic, Mormon and Catholic HTRs and HTRs after WWI and WWII. Elevated twinning rates in Gorlitz, Germany, 1651-1660 and 1761-1770 and in the U.S. (1970s) which the author correlates with post-war periods, are also discussed. Relationships described herein can be seen as predictable relationships if multiple birthing is considered a biosocial mechanism of population regulation in humans.

CHANGES IN SOYBEAN PEDUNCLE AND PETIOLE ANATOMY FOLLOWING CYTOKININ TREATMENT. Kuang Anxiu, Curt M. Peterson, and Roland R. Dute, Dept. of Botany and Microbiology, Ala. Agric. Exp. Stn., Auburn Univ., AL 36849.

Following treatment of soybean, Glycine max (L.) Merr., with the cytokinin, 6-benzylaminopurine (BAP), there was enhanced pod set on terminal racemes with an accompanying increase in girth of the raceme axis and of the petiole of the subtending leaf. Histological studies were conducted to determine the extent of BAP induced anatomical change in the raceme axis (rachis), and the timing and location of anatomical changes in petioles. Terminal racemes of field-grown 'Tracy-M' soybeans were sprayed with BAP to run-off four times at 2-day intervals during flowering (R2). In a second experiment, petioles at the last-formed nodes of field-grown, IX93-100 plants, a semi-determinate soybean line, were sprayed with BAP four times at 1-day intervals during late flowering (R4). Swelling of treated 'Tracy-M' peduncles, rachises and subtending petioles occurred within 4 to 6 days, and a significant increase in cross-sectional area was observed at lower nodes of rachises after 11 days. Increases in both width and cell number were observed in xylem and phloem tissues of treated rachises apparently due to accelerated divisions of a vascular cambium. Pith cells also increased in diameter following treatment. Procambial cells in vascular bundles of IX93-100 petioles responded to BAP treatment within 2 days by forming additional xylem and phloem. The relationship of these tissue changes to enhanced pod set is under investigation.

A HISTIOSTOMATID MITE, HISTIOSTOMA SP., PHORETIC ON A CHLOROPID FLY, ELACHIPTERA NIGRICEPS. Lawrence J. Hribar, Department of Entomology, Auburn University, Auburn, AL. 36849-4201.

The family Histiotomatidae (=Anoetidae), the slime mites, are commonly collected in wet or moist habitats rich in organic matter. Hypopi, or phoretic deutonymphs, disperse by attaching to winged insects. Histiotomatid mites, apparently an undescribed species in the genus Histiotoma Kramer, were collected from the decaying receptacles of the American lotus, Nelumbo lutea (Willdenow) Persoon, in Montgomery and Marshall Counties, AL, in the summer and fall of 1985. Adult females and hypopi were present in all collections. Hypopi were observed to attach to chloropid flies, Elachiptera nigriceps (Loew) immediately upon emergence of the adult fly from the puparium. Often so many hypopi attached to the fly that the fly itself was visible only with difficulty. Flies unsuccessfully attempted to remove hypopi by means of brushing motions of the legs. Several mites were seen attached to tachinid flies of the genus Lixophaga Townsend, which were assumed to be parasitoids of the Lotus borer, Ostrinia penitalis (Grote). Hypopi were never found attached to O. penitalis.

SEX, TISSUE AND STAGE SPECIFICITY OF VITELLOGENIN SYNTHESIS IN THE HOUSE CRICKET ACHETA DOMESTICUS. Deborah J. Bidanset and James T. Bradley, Dept. of Zoology and Wildlife Sciences, Auburn University, AL 36849.

Vitellogenesis in insects involves vitellogenin (VG) synthesis and secretion by the fat body and selective uptake of VG from the hemolymph by developing oocytes. In a few insects, the ovary is also a site of VG synthesis. The purpose of this study was to determine the tissue and stage specificity of VG synthesis in A. domesticus by characterizing polysomal mRNA extracted from pre-vitellogenic and adult ovary and fat body, analyzing proteins produced by these tissues during *in vitro* culture, and using an ELISA to estimate hemolymph VG in females at various times after ecdysis to the adult. *In vitro* translation (IVT) of polysomal mRNA extracted from adult fat body and ovary produced high and low molecular weight polypeptides that were immunoreactive with a VG-specific antiserum. These polypeptides may represent truncated translation products of VG mRNA as they were absent from IVT products of polysomal mRNA extracted from tissues of female nymphs. Incorporation of [35S]-methionine during *in vitro* tissue culture revealed ovarian VG synthesis occurring at about half the level (cpm/mg tissue protein) seen in the fat body. Results from the ELISA indicated that VG first appears in the hemolymph 14-16 hours after adult ecdysis. The study provides a basis for further work on the specificity of insect VG gene expression. (Supported by HATCH Project 665, Ala. Agricul. Experiment Station)

OBSERVATIONS ON THE BIOLOGY OF LARVAE OF THE GENUS MICRODON (SYRPHIDAE: DIPTERA). George W. Folkerts, Dept. of Zoology and Wildlife Science, Auburn Univ., Auburn, AL 36849.

The mollusk-like larvae of syrphid flies of the genus Microdon live in the nests of various species of ants where they may feed on ant larvae. Larvae possess a highly wettable cuticle which functions to facilitate the rapid spread of a fluid periodically exuded by pumping movements of the head. The fluid is suspected to be important in avoiding or inhibiting attack by the ant hosts. It may function as a repellent; an ant food; a chemical disguise; or an adhesive for the attachment of substrate particles. Pupae cannot exude the fluid but are not attacked. Adults are attacked by ants but crawl rapidly to escape from the nest.

THE IMPORTANCE OF SPARTINA ALTERNIFLORA TO THE GROWTH AND MORTALITY OF LITTORINA IRRORATA. Christopher J. McBride and Ann H. Williams, Dept. of Zoology and Wildlife Science, Auburn University, AL 36849.

In salt marshes at Dauphin Island, Alabama, it was shown that L. irrorata exhibit high mortality in predator exclusion cages devoid of S. alterniflora. When L. irrorata were allowed to graze only on Spartina and were excluded from the substrate, survivorship was high, but growth did not occur. Only in enclosures where snails had access to both Spartina and substrate was survivorship high and growth substantial. It appears that Spartina is required for survivorship, but the substrate is required for growth to occur.

## Abstracts

DEGRADATION OF CYANIDE BY MICROORGANISMS FROM COKE-PLANT MIXED LIQUOR. Johanna White, D.D. Jones and J.J. Gauthier, Dept. of Biology, Univ. of Alabama at Birmingham, Birmingham, AL 35294.

Three strains of aerobic pseudomonads were isolated from chemostats fed cyanide plus phenol or cyanide alone as the source of carbon and nitrogen. All strains were cyanide-resistant but only one degraded cyanide and utilized the liberated ammonia as a nitrogen source. Cyanide-degradation was enhanced by repeated exposure of the cells to cell-free extracts lost cyanide-degrading activity upon dialysis; activity was restored in the presence of NAD(P)H<sup>+</sup>.

INSECT VISITORS TO THE FLOWERS OF THE RARE PLANT, TRILLIUM RELIQUUM FREEMAN (LILIACEAE). Debbie R. Folkerts, John D. Freeman, and George W. Folkerts, Department of Zoology and Wildlife Science and Department of Botany and Microbiology, Auburn University, Auburn, AL 36849.

The rare plant, Trillium reliquum Freeman, is restricted to a few disjunct localities in Alabama, Georgia, and South Carolina. In Lee County, Alabama flowering peaks in late March and early April. Conspicuous among the flower visitors are small rove beetles (Staphylinidae) and a number of species of small flies of several families. The reddish-brown color and fetid odor are typical components of the sapromyophily syndrome in which pollination results from the visits of flies which oviposit in decaying organic material or fungi. The only reward which flower visitors can obtain is pollen since the flowers produce no nectar. Visitors are most abundant in the flowers during the period of high pollen availability.

ASPECTS OF THE BIOLOGY OF A MOTH (TRICHOPTILUS SP.:PTEROPHORIDAE) AND ITS PARASITOID (APANTELES SP.:BRACONIDAE) ON THE SUNDEW, DROSERA TRACYI. Susan Scott Porch, Debbie Rymal Folkerts, and George W. Folkerts, Dept. of Zoology and Wildlife Science, Auburn University, AL 36849.

The carnivorous plant Drosera tracyi (Droseraceae) occurs as locally abundant populations in isolated boggy sites along the Gulf Coastal Plain. The long, filiform leaves actively trap a variety of arthropod prey items. However, larvae of a pterophorid moth (Trichoptilus sp.) not only escape entrapment by the mucilage-tipped glands, but also feed and pupate on the Drosera leaves. Between July and September of 1986, a high percentage of the pterophorid larvae were parasitized by a braconid wasp of the genus Apanteles. This complex interaction between a carnivorous host plant, an insect herbivore, and a parasitoid warrants further investigation.

PSILOTUM NUDUM IN THE ALABAMA PIEDMONT. John D. Freeman, Department of Botany and Microbiology, Auburn University, AL 36849.

The whisk-fern, Psilotum nudum (L.) Beauvois, grows primarily as an epiphyte in the humid tropics worldwide and may occur on stumps and fallen trees in subtropical regions. Its sporadic range in the Southeast is mainly along the Atlantic and Gulf coasts from South Carolina to eastern Texas. This species, generally considered to be one of the most primitive extant vascular plants, is entirely terrestrial at the only known locality in Alabama. Diminutive aerial stems less than 10 cm in height were first observed near Auburn, Lee County, in October of 1986; these plants remained sterile until die-back occurred in late November, apparently due to low temperatures of the season. Specimens moved to clay pots and metal flats in the greenhouse have continued to grow without apparent interruption. Characteristics of this population, particularly the substratum and associated species, suggest that other inland populations of Psilotum may exist in the Southeast and should be searched for during late summer and fall.

SEXUAL DIMORPHISM IN THE BLACK-KNOBBED SAWBACK, GRAPTEMYS NIGRINODA. Mark A. Bailey and George W. Folkerts, Dept. of Zoology and Wildlife Science, Auburn University, Alabama 36849.

Male and female black-knobbed sawbacks, Graptemys nigrinoda, were examined for previously unreported sexually dimorphic features. Of the six features studied, two were found to differ significantly between the sexes. Relative to carapace length, males have larger hind foot areas (area covered by foot with toes and webbing spread) than females of similar size. The angle of the rear plastral notch is more acute in females than in males. When added to external sexually dimorphic features revealed in other studies, a total of eight such features are now known. Although Graptemys nigrinoda is a poorly known species, hypotheses may be made regarding selective pressures that have produced these differences. Such pressures may include reproductive functions, thermoregulation, and differential selection of traits due to niche partitioning.

## CHEMISTRY

OSCILLATORY BEHAVIOR OF ELECTRODEPOSITION OF COBALT. B. H. Loo, C. Riley, H. D. Coble and H. Abi-Akar, University of Alabama in Huntsville Huntsville, AL 35899.

Material processing in microgravity environment has attracted much attention recently. Gravity plays a significant role in processes which are affected by natural convection and sedimentation. There is evidence that electrodeposition in microgravity results in surfaces that have significant differences from those prepared on earth (1 g environment). Ehrhardt discovered that Ni deposited at a high rate under low g environment (Skylark 7 Rocket) and the resulting surface could not be etched by  $\text{HNO}_3$ . Electrodeposited Ni surfaces at 1 g are readily attacked by  $\text{HNO}_3$ . Grodska, et. al. found that Ag crystals formed in low g (Skylab) were smaller and more perfectly crystalline in terms of defined shapes or decreased morphology from those prepared at 1 g or 5 g environments.

In an attempt to model electrodeposition in low g experimentally, we designed an electrochemical cell such that it would eliminate macroscopic natural convection ("shielded" configuration). In the study of Co electrodeposition in the "shielded" configuration, we have made an interesting observation. The electrodeposition current ceased after 1-2 hrs of operation, and if the cell was agitated, oscillations in the current were observed under certain conditions. The oscillations could last for several hours. The cessation of current was caused by the passivation of the anode by a layer of  $\text{CoSO}_4 \cdot 5\text{H}_2\text{O}$  crystals, which when agitated, dissolved into the electrolyte. The oscillations were caused by re-deposition of  $\text{CoSO}_4 \cdot 5\text{H}_2\text{O}$  layer on the anode surface and the dissolution of this layer.

ACKNOWLEDGEMENT: This work was supported by NASA and McDonnell Douglas.

HISTORY OF THE WILSON DAM SECTION OF THE AMERICAN CHEMICAL SOCIETY.

Richard C. Sheridan, Division of Chemical Development, Tennessee Valley Authority, National Fertilizer Development Center, Muscle Shoals, AL 35660.

The Wilson Dam Section, with headquarters at Muscle Shoals, Alabama, received its charter on April 26, 1937. The late Dr. Earl H. Brown, TVA research chemist, became the first chairman. Membership has grown from the original 24 members to its present enrollment of 133. Most members are TVA employees (or retirees); the remainder are connected with Reynolds Metals Company, the University of North Alabama, and several other firms and schools. The Section's programs include lectures, seminars, awards, contests, instrument shows, and other activities. One of its most successful programs is an annual competitive examination for high school chemistry students. Because of these activities, the Section has been honored more than once as the "Outstanding Small Section" in the American Chemical Society.

## Abstracts

### CONTROL OF SULFUR FORMATION DURING PHOTOAUTOTROPHIC BIOCATALYSIS.

Douglas J. Cork and Al Wade, Dept. of Biology, Illinois Institute of Technology, Chicago, IL 60615. Robert J. Radel, Division of Research, Tennessee Valley Authority, National Fertilizer Development Center, Muscle Shoals, AL 35660.

Microbial sulfate decomposition processes and sulfide/sulfur dioxide elimination biohydrometallurgical processes require a basic understanding of the sulfur metabolism in anaerobic photosynthetic bacteria. In order to determine the feasibility of using micro-organisms such as Chlorobium or Chromatium species, the optimal quantum efficiency of the van Niel equation for the anaerobic production of sulfur must be found. The quantum efficiency of this reaction will permit a biochemical engineer to design a light-efficient photobioreactor for sulfur formation. A literature review indicates that there are no available action spectra for the determination of the optimal wavelength of the van Niel reaction given conditions in which the conversion of hydrogen sulfide gas to elemental sulfur is accurately controlled during an anaerobic gas to liquid phase reaction. Preliminary results suggest that the optimal wavelength for this reaction is not in the infrared at 840 nm, the reaction center for C.l.f.t. (Chlorobium limicola forma thiosulfatophilum), but rather at 550 nm. The quantum efficiency data suggest that a small percentage of light energy at 550 nm may be required for oxidative sulfur metabolism. Since kinetic evidence shows that the rate of sulfur formation in continuously stirred tank bench reactors is the highest in the photosynthetic anaerobes, optimal light and redox environmental conditions might be found which minimize biosynthetic processes and maximize the sulfur and acetate forming capabilities of C.l.f.t..

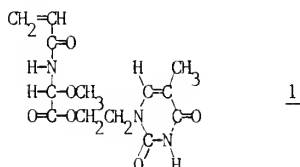
FOAM SEPARATION OF IRON(III) HYDROXIDE IN SOLUTION. Todd Williams, Dept. of Chemistry, John C. Calhoun State Community College, Decatur, AL 35602. Dr. Ben L. Currin and George Williams, Jr., Science Dept., John C. Calhoun State Community College.

Foam separation techniques, a division of adsorptive bubble separation techniques, are based on differences in surface activity. Particles of material are adsorbed on the surfaces of bubbles ascending through the liquid. The bubbles provide a surface to which the hydrophobic particles can attach. A substance which is not surface active may be made surface active by union with a surface active species. Theoretically, the primary factors which affect foam separation are the pH of the solution, ionic strength of salts, surfactant concentration, surfactant chain length, and specific adsorption of ions in solution. In this experiment the researcher is concerned with the separation of iron(III) hydroxide in a solution using sodium lauryl sulfate as surfactant. Factors such as the pH and surfactant concentration were varied in order to determine the most favorable conditions for rapid complete separation. Acknowledgements go to Dr. Ben Currin for providing information and designing these experiments and to George Williams for photographic advice.



POLY(ACRYLAMIDO N-GLYCOLIC ACID) AND POLY(ACRYLAMIDO GLYCOLATE METHYL ETHER) AND THEIR MONOMERS FOR THE SYNTHESIS OF POLYNUCLEOTIDE ANALOGS. Milton Mathis and Adriane G. Ludwick, Department of Chemistry, Tuskegee University, Tuskegee, Alabama 36088.

Polynucleotide analogs are molecules containing a synthetic non-sugar phosphate polymer backbone with pendants that are or contain nucleic acid bases such as thymine and adenine. This work explored the properties of water soluble polymers as backbones for these analogs. The polymers used were synthesized by a free radical polymerization in either aqueous or dimethyl formamide solution at 60°C. Poly(acrylamido N-glycolic acid) (PAG) appeared to have time variable solubility in water. Poly(methyl acrylamidoglycolate methyl ether) (poly(MAGME)) was apparently hydrolyzed to PAG when heated for periods greater than 30 minutes at 60°C. The infrared spectrum of a sample of poly(MAGME) heated for 24 hours in water is identical to that of PAG. Since these polymers were difficult to synthesize reproducibly, an attempt was made to synthesize the monomer (1) for a polynucleotide analog. MAGME was reacted with hydroxyethylthymine (HET) by a transesterification



reaction. Characterization of the reaction mixture is underway. However, it appears that hydrolysis of MAGME has occurred, rather than transesterification to give 1. (Supported by NIH RR 08091)

CRYSTALLIZATION STUDIES OF THE ENZYME UREASE. P.J. Twigg, S.B. Howard, and E.J. Meehan, Dept. of Chemistry, Univ. of Ala. in Huntsville, Huntsville, Al 35899

The use of urea as a plant nitrogen source has increased dramatically during the last few decades and indications are that this material will increase in importance as a solid nitrogen source in world agriculture. However, problems related to its use, such as damage to germinating seedlings and plants, nitrite and/or ammonia toxicity, and gaseous loss of urea nitrogen as ammonia have been attributed to the rapid hydrolysis of urea by soil Urease enzyme and may be alleviated by an appropriate enzyme inhibitor.

Crystallization experiments have been conducted to map the solubility of the enzyme Urease as a function of pH, ionic strength, temperature, and concentration of precipitating agents. Hundreds of crystallization conditions have been screened using the hanging drop vapor diffusion micromethod. Good crystals of the enzyme Urease have been produced from a variety of crystallization conditions. The crystals have been characterized by x-ray diffraction using both conventional x-ray generators and the Brookhaven National Synchrotron x-ray source. The crystals we produced are 80 times the length (5x10<sup>5</sup> times the volume) of any Urease crystals reported in the literature and diffract to a resolution of at least 3.5 Å.

EXPERIMENTAL STUDIES OF VAPOR EQUILIBRATION RATES IN THE HANGING DROP METHOD OF PROTEIN CRYSTAL GROWTH. P. Sapp, P.J. Twigg, S.B. Howard, and E.J. Meehan, Dept. of Chemistry, Univ. of Ala. in Huntsville, Huntsville, AL 35899

The "hanging drop" vapor equilibration method is currently one of the more popular techniques used for screening crystallization conditions and for growing diffraction quality protein crystals. An understanding of the simultaneous rate processes involved in this method would help to optimize the quality of the crystals formed. The rate of nucleation and crystal growth have different dependencies upon the degree of supersaturation. The degree of supersaturation is controlled by the rate of evaporation and the rate at which protein and precipitating agent are concentrated and the rate at which protein is incorporated into the solid phase. The rate of evaporation may be determined from diffusion theory and the colligative properties of solutions. All these rates are of importance in understanding the dynamics of protein crystal growth.

We have performed a series of experiments using the Linbro tissue culture plates to determine the effect on equilibration rates of differing precipitating agents and temperatures. Hanging drops were set up with the precipitating agents ammonium sulfate and polyethylene glycol 400 at both 4 degrees and 25 degrees Celsius. Concentration in the drop was determined as a function of time by sacrificing the drop and measuring its refractive index. Percent completion was calculated as a function of the concentration difference between the drop and the reservoir. In general, equilibration rate was found to decrease with decreasing temperature and decreasing concentration difference.

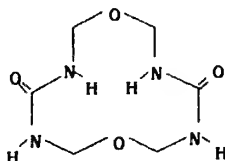
#### THE DETERMINATION OF LEAD IN SOLDER USING POTENTIOMETRIC STRIPPING ANALYSIS.

Barbara E. Fowler and Thomas Pierce, University of North Alabama Occupational and Environmental Health Laboratory, Florence, AL 35632.

Lead tap water pipes may pose a health risk if the water they transport shows elevated levels of lead ion. The U.S. Environmental Protection Agency has proposed a drinking water standard of 20 parts per billion. For new construction it is important to determine that solders being used in water supply systems do not contain lead. In this work, a relatively new electroanalytical method known as potentiometric stripping analysis is applied to the analysis of solder materials for lead. Potentiometric stripping is based upon the preconcentration of trace metal analytes using a constant voltage deposition on a mercury film electrode and the subsequent chemical reoxidation of the amalgamated analytes under well-defined conditions. The percentage of lead in a sample of solder was determined to be about thirty percent.

**FURTHER STUDY OF ALCOHOL-AMIDE REACTIONS.** Chester D. Moon and Thomas P. Murray. Department of Chemistry, University of North Alabama, Florence, Alabama 35630.

N,N'-Dimethylolurea, a condensation product of formalin and urea, is known to react readily with amides, such as urea, leading to the polymeric products known as ureaforms. The use of N,N'-dimethylolurea as a synthon for heterocyclic compounds has received little attention since most reactions of this compound do give polymeric products. We have investigated the preparation of oxygen and nitrogen heterocyclic compounds using N,N'-dimethylolurea. The macrocyclic ether, which we have tentatively assigned the structure below, is the product of the reaction of N,N'-dimethylolurea and ammonia.

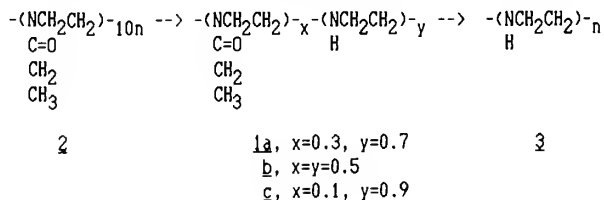


**A NEW SYNTHETIC ROUTE TO CYCLIC POLYARSINES.** Virendra K. Gupta, Larry K. Krannich, and Charles L. Watkins, Department of Chemistry, University of Alabama at Birmingham, Birmingham, AL 35294.

Cyclic polyarsines,  $(\text{RAS})_n$  ( $\text{R} = \text{Et}$ ,  $n\text{-Pr}$ ,  $n = 5$ ;  $\text{R} = \text{Ph}$ ,  $p\text{-Tol}$ ,  $n = 6$ ), form in good yields from reaction of  $(\text{MeAs})_5$  with  $\text{RAS}_2\text{H}_2$  upon elimination of  $\text{MeAsH}_2$ . The reaction of  $(\text{MeAs})_5$  with  $\text{PhAsH}_2$  in a 1:5 mole ratio in toluene- $d_8$  was also investigated by means of  $^1\text{H}$  and  $^{13}\text{C}$  NMR spectroscopy over the temperature range of  $-80$  to  $24^\circ\text{C}$  as a function of time. The NMR spectral data suggest that cleavage of the  $(\text{MeAs})_5$  ring occurs to give an equilibrium mixture of linear, hydrogen terminated, mixed polyarsines,  $\text{Me}(\text{H})\text{As}(\text{AsMe})_x(\text{AsPh})_y\text{As}(\text{H})\text{Ph}$ ; cyclic  $(\text{PhAs})_6$ ;  $\text{PhAsH}_2$ ; and  $\text{MeAsH}_2$ . Several competitive exchange reactions involving compounds capable of exchanging  $\text{H-}$ ,  $\text{MeAs-}$ , and  $\text{PhAs-}$  moieties occur in solution and influence the overall rate of reaction and the establishment of equilibrium. An increase in the temperature of the reaction mixture and/or a decrease in pressure above the reaction solution shifts the equilibrium toward cyclic  $(\text{PhAs})_6$  via  $\text{MeAsH}_2$  elimination. The unsymmetrical diarsine,  $\text{Me}(\text{H})\text{AsAs}(\text{H})\text{Ph}$ , possessing two chiral centers, was a minor product in solution.

PARTIALLY HYDROLYZED POLY(2-ETHYL-2-OXAZOLINE). Adriane G. Ludwick, Joel McCloud, Jr., Robinson Ramirez and Anthony Woods, Department of Chemistry, Tuskegee University, Tuskegee, AL 36088.

Preliminary studies have shown that 70 percent hydrolyzed poly(2-ethyl-2-oxazoline) (1a) demonstrated antiviral properties against herpes simplex II and a measles virus. To determine if percent hydrolysis is a factor in the biological activity of the hydrolyzed polyoxazoline, 1b and 1c (50 and 90 percent hydrolyzed samples) have been synthesized and



characterized and submitted for biological testing. Viscosity measurements indicate polyelectrolyte behavior for 1.  $^{13}\text{C}$  NMR spectra indicate the expected structures for 1a and 1c. Two absorptions assigned to  $\text{CH}_2\text{CH}_2\text{NH}$  are observed for 1b. Low intensity absorptions in the  $^{13}\text{C}$  spectra indicate primary structure differences from the general structure 1. Light scattering data on 2 and the completely hydrolyzed polymer poly(ethylenimine) (3) show a 10-fold reduction in the degree of polymerization. This indicates a complex structure for 2 and a correspondingly complex structure for 1. The relationship of these observations to the actual structures for 1a, 1b and 1c, as well as any antiviral activity for these polymers, is under investigation.  
(Supported by NIH RR 08091)

#### THE IDENTIFICATION OF ASBESTOS USING THE FOURIER TRANSFORM INFRARED SPECTROMETER (FTIR).

Eleonore M. Cochran and Thomas Pierce, University of North Alabama Occupational and Environmental Health Laboratory, Florence, AL 35632.

Asbestos, the name given to a variety of crystalline and fibrous silicates, is known to cause asbestosis, mesothelioma, and bronchogenic carcinoma. Asbestos-containing materials (chrysotile and amosite) have been identified using a variety of techniques such as polarized and phase-contrast microscopy, x-ray diffraction, and electron microscopy. The use of infrared spectroscopy for this purpose has been limited to date; our work involves the use of an FTIR to provide data complementary to those obtained using polarized light microscopy. Asbestos samples were prepared using compressed KBr disks (10:1 KBr and asbestos). The spectra showed characteristic absorption in the regions from  $1200 - 900 \text{ cm}^{-1}$  (Si-O stretching) and  $600 - 400 \text{ cm}^{-1}$  (bending vibrations). This preliminary data may be used to form the basis for a more definitive method.

CHARACTERIZATION OF ELECTROCHEMICALLY GENERATED STOICHIOMETRIC FILMS ON PALLADIUM ELECTRODES BY LASER RAMAN SPECTROSCOPY. B. H. Loo and Y. G. Lee, Department of Chemistry, University of Alabama in Huntsville Huntsville, AL 35899.

Under anodic polarization in chloride solutions, palladium electrode goes into solution as Pd(II) complex ions at potential from 0.35 to 0.50 V vs saturated calomel electrode (SCE), and at sufficient high  $\text{Cl}^-$  concentration, the  $\text{PdCl}_4^{2-}$  complex is formed. Finally, Pd dissolves as Pd(IV) at potential of  $\text{Cl}_2$  evolution with the formation of  $\text{PdCl}_6^{2-}$ .<sup>1</sup>

In certain bromide and chloride solutions, surface films are formed on the Pd electrode surface at high anodic potentials. These surface films are characterized by the laser Raman spectroscopy technique. In the presence of  $\text{K}^+$ ,  $\text{NH}_4^+$ ,  $\text{Rb}^+$  and  $\text{Cs}^+$  ions, the surface films are identified to be hexachloropalladates ( $\text{PdCl}_6^{2-}$ ) and hexabromopalladates ( $\text{PdBr}_6^{2-}$ ) of these cations. The observed Raman frequencies ( $\nu_1$ ,  $\nu_2$ , and  $\nu_5$ ) agreed well with those reported in the literature.<sup>2</sup>

1. T. Heumann and R. Scurmann, Ber Bunsenges. Phys. Chem. **67**, 601 (1963).
2. M. Debeau and H. Poulet, Spectrochim. Acta **25A**, 1553 (1969).

ACKNOWLEDGEMENT: This work was partially supported by NSF-Alabama EPSCoR Program.

ADSORPTION OF SUCCINONITRILE AT THE COPPER-AQUEOUS ELECTROLYTE INTERFACE. B. H. Loo and Y. G. Lee, Department of Chemistry, University of Alabama in Huntsville, Huntsville, AL 35899. D. O. Frazier, Space Science Laboratory, NASA Marshall Space Flight Center, Huntsville, AL 35812.

Succinonitrile-water binary system has received considerable attention as a model system in material processing because it permits visual observation of phase transformations during solidification. Our study of thermally driven surface phenomena associated with the solidification process such as thermal migration, critical wetting, and Ostwald ripening, etc. necessitates accurate solution temperature measurements and has lead to an interesting observation. Copper-Constantan thermocouples, used in the temperature measurements, break upon prolonged contact with succinonitrile-water solutions. Preliminary atomic absorption spectroscopic results indicate that the corrosion is initiated at the copper-succinonitrile interface. In order to better understand the initiation of the corrosion process, we use surface-enhanced Raman spectroscopy to study the molecular interaction at the copper-succinonitrile solution interface under potentiostatically controlled reactions. Both the rotational isomers, gauche and trans, are found to coordinate to the copper surface through the  $\pi$ -system of one of the two CN groups.

ACKNOWLEDGEMENT: This work was supported by International Copper Research Association (INCRA) and by NASA.

SYNTHESIS AND PHARMACOLOGICAL PROPERTIES OF 1-ARYL-3-METHYL-2-PYRAZOLIN-5-ONE CONDENSATION AND ACYLATION PRODUCTS. Jack DeRuiter, Deborah A. Carter, Charles K. Born and Priscilla P. Davidson, Department of Pharmacal Sciences, School of Pharmacy, Auburn University, AL 36849.

A variety of condensation and acylation reactions were explored with several 1-aryl-3-methyl-2-pyrazolin-5-ones (1). In the presence of substituted benzaldehydes, an aldol-type condensation occurred with 1 resulting in the formation of E- and Z-4-benzylidene-1-aryl-3-methyl-2-pyrazolin-5-ones. Attempted condensation of 1 with formanilide, however, did not yield the expected 4-(arylamino)methylidene product, but rather gave 4,4'-methylenebis(1-aryl-3-methyl-2-pyrazolin-5-one). Also treatment of 1 with benzoyl chlorides afforded the 5-O-acylation products instead of the expected C-4-acylation products. The chemical reactivity of the 4-benzylidene products was also investigated under a variety of reaction conditions. In the presence of nucleophiles, these compounds readily undergo conjugate addition reactions to yield unstable addition adducts. When subjected to catalytic hydrogenation, the 4-benzylidenes are reduced to the corresponding 4-benzyl derivatives which can be alkylated at N-2 with alkyl halides or alkyl sulfonates. Due to their structural similarity to known anticonvulsant and anti-neoplastic agents, several of the 4-benzylidenes and derivatives were tested as potential anticonvulsant and antitumor agents. Several of these compounds were also tested for their ability to alter calcium-induced contractions in uterine smooth muscle. The results of these evaluations, as well as the details of the syntheses and reactions of these compounds will be presented.

INDIRECT DETERMINATION OF CALCIUM IN FERTILIZER MATERIALS BY ION CHROMATOGRAPHY. Kathleen A. Baumgart and Richard C. Sheridan, Division of Chemical Development, Tennessee Valley Authority, National Fertilizer Development Center, Muscle Shoals, AL 35660.

In the simultaneous determination of fluoride, phosphate, and sulfate in phosphogypsum, phosphate rock, and other fertilizer materials by ion chromatography, the high calcium content interfered with the phosphate determination. After treatment of the sample solution with sodium oxalate to precipitate the calcium, accurate phosphate results were obtained. The excess oxalate was determined simultaneously with the fluoride, phosphate, and sulfate anions. The difference in the oxalate peak areas of a standard solution and the treated sample then was used to calculate the calcium content. The results corresponded to 101% of the calcium content obtained by standard analytical methods. The precision (coefficient of variation) was 2.58.

**SEPARATION AND ANALYSIS OF p-DIMETHOXYBENZENE AND p-METHOXYPHENOL.** Darryl W. Worley and Thomas P. Murray. Department of Chemistry, University of North Alabama, Florence, Alabama 35630.

A typical undergraduate experiment in organic chemistry, to introduce the use of liquid-liquid extraction is the separation of an acidic compound (p-methoxyphenol) from a structurally similar neutral compound (p-dimethoxybenzene). Although theoretically sound this experiment is pedagogically weak because the student must typically rely upon melting point as an indicator of product purity. In the case of the title compounds both melt between 55° and 58° C.

An HPLC method has been developed, based on a reversed-phase separation, for the rapid, quantitative analysis of the two title compounds. The method will be explained and the results from analysis of several student samples will be given. The application of this experiment to a "micro-scale" organic laboratory setting will be discussed.

**AN INTRODUCTION TO MOLECULAR GRAPHICS USING A MICROCOMPUTER.** William E. Fair, J. Larry Morris, and Thomas P. Murray. Department of Chemistry, University of North Alabama, Florence, Alabama 35630.

An experiment designed to afford a meaningful introduction to molecular modeling at the undergraduate level will be described. A commercial program [Molecular Animator, Jeff Howbert, COMPress] was used on the Apple IIe computer and the techniques of data entry will be discussed. Several examples will be shown of molecules with varying complexity, including the dodecahedron and buckminsterfullerene. A video tape will be shown to illustrate the rotation of several example molecules about cartesian coordinates both in the carbon skeleton and the ball and stick formats.

## Abstracts

APPLICATIONS OF CHEMICAL MICROSCOPY: USING PLM AND SEM TO CHARACTERIZE AND IDENTIFY SOLIDS IN INDUSTRIAL PROBLEMS. D. J. Ray, Division of Research, Tennessee Valley Authority, National Fertilizer Development Center, Muscle Shoals, AL 35660.

Many chemists are not familiar with the methods and techniques of polarized light microscopy (PLM) for the identification of solids, although mineralogists have used PLM for such purposes for many years. The theory and background of PLM are briefly reviewed and microchemical spot tests for several ions ( $\text{NH}_4$ , Fe,  $\text{PO}_4$ , and  $\text{SO}_4$ ) demonstrated. The examples of microscopy identification of solids from industry include: (1) analysis of asbestos in insulation materials by the Environmental Protection Agency recommended method; (2) environmental problems to identify air-borne solids as possible sources of pollution; (3) chemicals such as gypsum, anhydrite, of ferrous sulfate found as pipe scale in industrial plants; (4) foreign materials contaminating bulk fertilizer; and (5) liquid-solid phase diagram of urea-ammonium-phosphate-water system.

USE OF TARGET FACTOR ANALYSIS TO CALCULATE ACID DISSOCIATION CONSTANTS. William F. Arendale, Department of Chemistry, Univ. of Alabama in Huntsville, Huntsville, Alabama, 35899.

Acid dissociation constants are frequently used to characterize reactivity and extent of reaction. Target factor analyses of spectrophotometric data has proven to be a useful computational method for smoothing of data, characterizing anomalies in the data, and calculation of fraction of each component in the mixture. Linear regression analysis provides a statistical method for the evaluation of the constant that gives the best fit to the data. The number of wavelengths used is limited only by size of the computer.

This analytical method will be compared to several empirical methods that have been described in the literature.

GENERAL CHEMISTRY GRADES AS FUNCTIONS OF SEVERAL VARIABLES.

Raymond E. Isbell, Ph.D., and Sally Craig, Authors.  
University of North Alabama, Florence, Alabama 35632

A study was made at the University of North Alabama for the period 1980-1985 of the relationship of student grades in CH 111 - General Chemistry to ACT scores and grades made on several related high school and college courses. There was considerable scatter in the data but long-term averages usually showed significant trends. A scale was developed for feeder high schools based upon the relationship of grades received in CH 111 and high school chemistry grades.



## Abstracts

Cellulose Hydrolysis: Investigation of Reaction Kinetics by Weight Loss. Michael B. Moeller and Michael R. Ezell, Department of Chemistry, University of North Alabama, Florence, Alabama 35632.

The reaction kinetics of the dilute acid hydrolysis of microcrystalline cellulose has been investigated by measuring the weight of insoluble material lost from cellulose-acid mixtures as a function of time. An interference occurs with this technique. The formation of insoluble glucose degradation products results in rate constant values which are too small. We have investigated this interference by analyzing the amount of cellulose in the hydrolyzate residue using a quantitative saccharification procedure. The data indicate that the interference in the weight loss method can be removed by adding a term which is quadratic in time to the semilog plot of the first order reaction data. The coefficient of the first order term appears to give an unbiased measurement of the hydrolysis rate constant.

AN INTERPRETATION OF THE ELECTRONIC SPECTRA OF ARENETRICARBONYLCHROMIUM COMPLEXES. Michael C. Reid, J. Rawlings, and C.A.L. Mahaffy, Dept. of Chemistry, Auburn University at Montgomery, Montgomery, AL 36193.

The ultraviolet spectra of a series of substituted arenetricarbonylchromium complexes have been obtained. The spectra consist of 2 or 3 high intensity bands ( $\epsilon > 10^4$ ) with the lowest energy band ( $\lambda \sim 320$  nm) assigned as a charge transfer band from the metal to the ligand. Spectral parameters ( $\epsilon, \lambda$ ) have been correlated with the Hammett parameters ( $\sigma_p$ ) which relate to the nature of the arene substituent. The substituents reported will include alkyl, amino, ester, and alkoxy groups.

### A SIMPLE METHOD FOR ESTIMATING FORMALDEHYDE RELEASE RATE COEFFICIENTS FROM SELECTED WOOD PRODUCTS.

William H. Simpson and Thomas Pierce, University of North Alabama Occupational and Environmental Health Laboratory, Florence, Alabama 35632.

The Japanese Industrial Standard desiccator method provided relatively quick and general information concerning formaldehyde emissions from the pressed wood products tested. Two types of wood paneling studied had hourly emissions for the first 24-hour period of 190 and 245  $\mu\text{g}/\text{m}^2\text{-hr}$  respectively, using duplicate samples. A methodology employing a chromogenic substrate known as Purpald ( $\text{C}_2\text{H}_6\text{N}_6\text{S}$ ) provided simple and accurate analyses of aqueous formaldehyde. This method appears useful for individuals with little training in analytical chemistry or emissions testing.

## GEOLOGY

### STORM-ASSOCIATED SAND BEDS OF THE EUTAW FORMATION OF THE CHATTAHOOCHEE RIVER VALLEY AREA: PRELIMINARY DESCRIPTIONS AND SIGNIFICANCE.

David L. Violette and David T. King, Jr., Dept. of Geology, Auburn Univ., Auburn, AL 36849.

The Upper Cretaceous (Santonian) Eutaw Formation in the region of the Alabama-Georgia border is comprised in part of clayey lagoonal facies which host sandy event beds, 1 cm to 1 m thick. A storm origin for these sandy beds is indicated by the abundant hummocky cross-stratification developed in fossiliferous, micaceous, silty, fine to very fine quartz sand which contains abundant fine macerated plant detritus. A rapid emplacement of the beds consistent with the storm origin is indicated by common basal load structures, including ball and pillow, in the subjacent lagoonal muds. Preliminary correlations and field studies indicate that thickness of beds is unrelated to their lateral extent. Storm beds less than 15 cm thick tend to be 1) more affected by post-event burrowing and 2) laden with few bivalves and wood pieces over 2 mm in size. Storm beds over 15 cm thick tend to have: 1) sharp erosional bases, 2) more bivalves, 3) a vertical gradient of bivalve abundance within a bed, 4) a lack of wood pieces of 2 mm size, and 5) fewer completely penetrating post-event burrows. The thicker storm beds are also commonly amalgamated with other sand beds. These characteristics suggest that the thicker beds are more proximal to the base-level sand source, and that storm bed type seems to be a paleobathymetric indicator.

Stratigraphic Relations, Age, and Depositional Environments of the Turnipseed Dinosaur Site in the Demopolis Chalk (Upper Cretaceous), Montgomery County, Alabama. David T. King, Jr. and Janet P. Abbott-King, Dept. of Geology, Auburn University, AL 36849.

On July 2, 1982, the authors discovered a significant number of dinosaur bones in an outcrop beside a Montgomery County Highway approximately 1.8 km north of Downing, Alabama. This location, now known as the Turnipseed Dinosaur Site (TDS), contained the bones of the best and most completely preserved eastern American tyrannosaurid (D. Russell, Natl. Mus. Canada, pers. comm.). Stratigraphic relations of the TDS measured section were determined by serial-section projection (considering basal elevation and dip). This projection shows that the carnosaur bones lay 10 m above the base of the Demopolis Chalk. This stratigraphic position indicates a Late Campanian (73-78 Ma) age for the specimen. The TDS strata are shelf deposits which consist of bioturbated marls and calcareous clays bearing marine fossils such as nannoplankton, foraminifera, ostreids, Anomia, and Exogyra. Coeval clastic facies (in the Cusseta Sand) are located 25 km to the east. Because the carnosaur was terrestrial, some process transported the bones roughly that distance onto the shelf. Sand content of the bone bed, disarticulation, and parallel alignment of bones suggests that a storm-surge ebb current or turbidity current was the transport mechanism.

FACIES STRATIGRAPHY AND DEPOSITIONAL ENVIRONMENTS OF THE UPPER PART OF THE SMACKOVER FORMATION, MISSISSIPPI INTERIOR SALT BASIN, ALABAMA. Randall J. Hunt and David T. King, Jr. Dept. of Geology, Auburn Univ., Auburn, AL 36849.

Eight drill cores have been studied in order to determine the facies and stratigraphic relationships for the upper part of the Smackover Formation (Late Jurassic, Oxfordian) in the Mississippi Interior Salt Basin of Alabama. Five preliminary facies have been delineated from initial petrologic descriptions and are listed in ascending stratigraphic order. Facies 1 is a homogenous mudstone to wackestone which contains very few pellets. Facies 2 is a bioturbated wackestone to packstone which contains bivalve shell fragments and abundant pellets. Facies 3 is a homogenous packstone which contains Favreina pellets, algal intraclasts, and bivalve shell fragments. Facies 4 is a homogenous packstone to grainstone which contains oolites, pellets, and algal intraclasts. Facies 5 is an oolitic grainstone which is cross-bedded and contains relatively few pellets. Although these facies interfinger, their vertical arrangement comprises a coarsening-upward textural sequence. The presence of higher energy facies (Facies 3 to 5) in the upper portion of each drill core and the down-dip thickening of this package of facies are evidence for deposition on a carbonate ramp. The progradation of the high-energy facies across the ramp is attributed to the eustatic regression at the end of the Oxfordian reported in other regions.

TRIPOLI IN NORTHWEST ALABAMA--OCCURRENCE AND GENESIS. Karen F. Rheams and Karen E. Richter, Geological Survey of Alabama, P.O. Box 0, Tuscaloosa, AL 35486.

Tripoli, a soft, friable, porous rock composed of extremely fine-grained (microcrystalline) quartz, occurs in several areas in Alabama. Its hardness and chemical inertness make tripoli valuable as an abrasive and mineral filler. Large, commercial-quality tripoli deposits occur in the upper part of the Fort Payne Chert in Lauderdale and Colbert Counties, northwest Alabama. The tripoli in these counties is composed of angular aggregates of crystalline quartz with less than 1.5 percent impurities. Locations of the known tripoli deposits in northwest Alabama appear to be coincident with lineament-identified fracture intersections that could allow for increased groundwater movement within the rock units. Comparisons of scanning electron micrographs of the tripoli and the parent Fort Payne Chert lithologies suggest that the tripoli in northwest Alabama formed by dissolution and reprecipitation of the silica in the parent rock possibly along fractures and at fracture intersections. Dissolution of the Fort Payne Chert may have been enhanced by alkaline groundwater circulating within the upper part of the formation. A decrease in the alkalinity of the groundwater caused by contact of the groundwater with the subsided shales of the Pride Mountain Formation may have resulted in the precipitation of the dissolved silica to form tripoli.

ADDITIONAL INVESTIGATIONS IN NORTHWEST ALABAMA CAVES. Gorden L. Bell, Jr., and James P. Lamb, Jr., Red Mountain Museum, Birmingham, AL 35205

The Wisconsin cave site at ACb-3 is an internally drained settling basin and has accumulated bone-bearing colluvial detritus from three main source areas. One of these is a sinkhole talus/scree deposit, and is interpreted as an animal trap because of the inclined attitude of several relatively complete specimens. A long tunnel contains what probably was a fissure deposit which emptied into the cave, was transported down the tunnel by running water, and settled out in rim-stone pools. The third type of deposit consists of chert fragments and clay transported through the original mouth of the cave, and constitutes the majority of the deposits on the floor. Within each deposit are found discreet individuals that appear to have entered the cave whole, whether seeking shelter, as prey, or from an accidental fall. All the bone-bearing deposits lie on top of a sterile, subaqueously deposited, silty clay. The tunnel contains a large number of sloth bones in the immediate vicinity of an old disturbance. Several of these, when compared to material from Alabama (described in 1855 by Joseph Ledy) in the collections of the Philadelphia Academy of Natural Sciences, are seen to be identical, even to the most minute details of preservation. This information has convinced the authors that this cave is the site of the original 1851 discovery. The deposits surrounding these bones are beds of clay separated by layers of travertine which have been dated at  $228K \pm 17K$ ,  $172K \pm 10K$ , and  $115-121K \pm 5K$  by the Uranium/Thorium method. Sloth bones are found between the middle and youngest travertines and above the youngest. The ANSP specimens include bones from both levels. The faunal list continues to grow, and to date, remains of twelve (12) individual ground sloths (Megalonyx jeffersoni) have been found.

THE MOSASAUR CLIDASTES: NEW SPECIMENS AND NEW PROBLEMS. Kenneth R. Wright, Dept. of Biology, University of Alabama at Birmingham, Birmingham, AL 35294.

The mosasaur Clidastes has received little attention since John C. Merriam described C. liodontus in 1894. Recently, new material has been collected from the Upper Cretaceous of Alabama, Nebraska, and Wyoming, including several examples of an undescribed species. The new form differs markedly in its cranial anatomy from either C. liodontus or C. propython (Cope 1869). It is presently known from over a dozen well preserved specimens from the lower unnamed member of the Mooreville Chalk Fm. (early/mid-Campanian) of Alabama and the Sharon Springs Member of the Pierre Shale Fm. (mid-Campanian) of Wyoming and Nebraska.

Unfortunately, questionable validity of the name Clidastes is delaying description of the new species. E.D. Cope (1868) based the genus on a single anterior thoracic vertebra from the Marshalltown Fm. (late Campanian) of New Jersey. The author suspects that the generic holotype of Clidastes may be indistinguishable from anterior thoracics of Mosasaurus conodon (Cope 1881). If this proves true, then Clidastes must be regarded as nomen vanum, and the junior synonym Edestosaurus (Marsh 1871) would replace it. The holotype of Marsh's E. dispar (= C. propython) includes a fairly complete skull (Niobrara Chalk Fm., lower Campanian), and would make a suitable generic holotype.

## Abstracts

CONCRETIONARY LIMESTONE GROWTH HISTORY AS INDICATED BY BIOGENIC SEDIMENTARY STRUCTURES: AN EXAMPLE FROM THE JURASSIC POSIDONIENSCHIEFER (GERMANY). Charles E. Savrda, Dept. of Geology, Auburn Univ., AL 36830.

The sedimentologic importance of concretions within mudrocks is generally well known. Sedimentary fabric that has been destroyed or obscured in surrounding sediments is often well-preserved within concretions and the characteristics of that fabric are useful for evaluating the general timing of concretion formation. Recent study of a concretionary limestone bed (CLB) within the Jurassic Posidonien-schiefer of southern Germany indicates that trace fossils may record a more detailed history of syngenetic concretion growth than previously recognized. This CLB is characterized by boudinage-like geometry (6 to 20 cm thick) and exhibits vague primary lamination indicative of oxygen-deficient depositional conditions. All trace fossils associated with the CLB originate from an overlying thin green claystone bed that records a short oxygenation episode. Trace fossil distribution varies systematically with position. Many crest areas of "boudin" portions of the CLB lack trace fossils and only primary fabric remains. The upper half of the CLB between crests is characterized by 20 to 25 "layers" of Chondrites that are highly compressed in the trough areas and gradually diverge toward the crests where they often end abruptly. The lower half of the CLB is unbioturbated internally. However, Rhizocoralium, stenomorphic Thalassinoides, and rare Chondrites occur along the undulatory base of the bed. These patterns indicate that concretion growth was initiated at isolated nuclei at a very shallow depth below the seafloor prior to both compaction and the oxygenation episode. Cementation continued downward and laterally from these nuclei during and after minor compaction but was completed before the termination of the oxygenation event at a depth less than 1 m below the seafloor.

## FORESTRY, GEOGRAPHY, CONSERVATION AND PLANNING

DISPOSSESSION OF THE CROW INDIANS. Richard M. Glover, Dept. of Geography, Univ. of Ala., Tuscaloosa, AL 35487.

The dispossession of the group of Plains Indians known as the Crow was primarily a nineteenth-century process by which a series of historical forces operated to systematically truncate and delimit traditional Crow territory and lifestyles. The dispossession of the Crow Indians was both a territorial and culturally based phenomenon which, in a period of less than one hundred years, resulted in the fundamental restructuring of the traditional Crow way of life. The process of dispossession is conceptually analyzed from a "stage" framework by which three distinct phases of developments in the nineteenth and early twentieth-centuries led to the fundamental transformation of Crow territory, and political, social, and economic systems.

RESOURCE ENHANCEMENT IN THREE SOUTH AMERICAN COUNTRIES. Wilbur B. DeVall, President, Proxy Services Ltd., Auburn, AL 36830

Early Indian settlement and development in South America have left many archeological remnants and artifacts which characterized each culture. The geography of the continent limited tribes to regions near the coast, inland in the mountains, or to open areas where livestock could graze without man's input. Minerals such as gold and silver were primary attractions for some while fertile soils, forests, and grassland provided the necessities required by man. Spanish conquistadores vanquished many Indian tribes leaving only ruins, burial grounds, and tombs as records of their life styles, artistic talents, and cultural accomplishments. Since 1500 AD the Spanish, Portuguese, Germans, Italians, and British have exploited surface and below-ground resources along and adjacent to the coastline of the continent. Vast forest reserves still exist in the Amazon River basin which includes more than 600 square miles. These selyas represent the largest area of continuous forest in the world. Early exploration for gold, silver, and gem stones led to the establishment of industry primarily adjacent to the coast. Major cities have followed this trend in their development and are concentrated along the Pacific and Atlantic ocean coastlines. Productive lands are limited to areas receiving enough rainfall to support vegetation. The coastal area of Peru in the vicinity of Lima receives but one inch of rainfall per year. The tropical rain forests receive rain in excess of the grasslands of Argentina (Pampa) which produce beef and other agricultural crops without the benefit of fertilizer. Some of the coastal areas, such as those around Buenos Aires, have been built up by deposition of silt brought toward the coast by rivers originating in the mountains or the Amazon basin.

SLUM DWELLERS OF KANPUR, INDIA : A STUDY OF THEIR HABITAT, ECONOMY AND SOCIAL STRUCTURE. Surendra P. Mathur, Dept. of History & Political Science, Ala. A & M Univ., Normal, AL 35762.

The paper examines the housing and socio-economic condition of slum dwellers in the city of Kanpur, India. More than sixty percent of its 1.7 million people live in substandard housing. About 800 slum compounds, locally known as Ahatas, exist as pockets of urban poverty, squalor and overcrowding. The study of one of these Ahatas concludes that 973 persons were living in one hectare of space that included 210 households. Fiftysix percent houses had mud floor, 31 percent mud wall and 45 percent tile and thatch roof. Forty-two percent working population was employed as industrial labor and 36 percent in informal sector of urban economy. Eighty six percent households were nuclear families; while 73 percent lived in single room dwellings. Only 24 percent houses had water taps, 34 percent electricity and 23 percent toilets. Forty eight percent people were illiterates and 38 percent educated to primary and secondary level. Average household income was approximately \$ 405 and per capita income \$ 87 per annum. Sixty four percent earned less than \$ 360 per annum.

VARYING ESTIMATES OF PRODUCTIVE CAPACITY OF FARMLAND

H. A. Henderson, Agricultural Institute, TVA

Throughout recorded history man has sought assurance of sufficient land for secure food supplies as population increased. Estimates of adequacy vary dramatically between times and estimators. Debates of adequacy peaked during food shortages of the 70s, but have subsided. Reasons for differences in appraisal were examined. I. Generally, predictions of land shortage rise during periods of food shortage. II. Statistical estimates of reserve land have changed as methods of measurement have improved. Adjustments for size and shape of field and erosion hazard reduced potential production estimates by about half in one study. Also, only about 7 percent of the noncropland in the Tennessee Valley has high potential for conversion due to ownership, isolation, and other factors.

Even with improvements in measurement, different concerns associated with philosophy of the estimator remain. Two main world views dominated the past debates: (1) Malthusians, or pessimists, who expect increasing hunger to dominate the future, and (2) cornucopians, or optimists, who expect only food abundance. A third group called Jeremiads has recently been identified. Their outlook is shared with Malthusians to alert planners to developing conditions and warn of impending hunger unless actions are taken. But it shares with cornucopians the hope for food abundance if actions are taken.

There is little hope of settling debates on adequacy of land for future food needs. But, there is hope for improving measurement methods and of understanding reasons for differences in opinions.

THE SHOALS INDUSTRIAL DEVELOPMENT INFORMATION SYSTEM (SIDIS).

Dr. William R. Strong, Department of Geography, University of North Alabama, Florence, Alabama, 35632-0001. Eddie D. Lenz, Department of Geography, University of North Alabama, Florence, Alabama, 35632-0001.

The extensive use of spatial information in the decision-making process of city and county governments and other development oriented organizations of the Shoals area has created the need for a centralized multipurpose geographical information system. SIDIS is being developed to meet these needs and also to provide a means to monitor the incremental spatial development of the area. Utilizing satellite data and remote sensing capabilities, the system will also be able to monitor landuse/landcover change. SIDIS is being tailored to meet the needs of the Shoals Industrial Development Authority (SIDA), but its multipurpose aspect will be useful to state agencies, county organizations and city governments, or anyone with a need for spatial information related to industrial or other types of development.

THE TRANSPORTATION VARIABLE IN PLACES RATED ALMANAC REEVALUATED.

Frank N. Himmeler, Dept. of Geography, Univ. of North Alabama, Florence, Alabama, 35632-0001.

The ranking of metropolitan areas in the United States by the use of quality of life indicators has become quite popular in recent years. Of the numerous studies published, Rand McNally's Places Rated Almanac by Boyer and Savageau is perhaps the best known. However, a number of deficiencies emerge when Places Rated is examined critically. One of these is the grouping of all 329 metropolitan areas together. Larger cities with greater needs for transportation services will normally generate responses to fill these needs. Cities of comparable size should be the basis for comparison. Another weakness is the weighting applied to each of the five variables. Daily commute time, availability of public mass transit, number of Interstate highways, number of airline flights and number of Amtrak departures are each given equal weight. To correct this problem, each variable is weighted according to its percentage of usage at the national level. Commute time is weighted at 1.000 because most of the population is involved in some form of commuting. Public mass transit is weighted at .082 due to the fact that only 8.2% of the population uses public transportation when commuting. Weighting of airline flights is .146 due to 14.6% of inter-city travel being by air. Only .7% of travel is by Amtrak producing a weight of .007. Interstate highways were deleted due to a number of technical problems. Many highways that are not Interstate routes are of comparable quality and need to be given consideration. Other types of roads and the number of traffic lanes should also be considered. Overall, considerable changes in ranking occur when the variables of transportation are weighted by frequency of usage.

LANDSCAPE EXPRESSIONS OF RURAL GENTRIFICATION IN THE BLACK BELT OF ALABAMA, 1830-1860. David C. Weaver, Dept. of Geography, Univ. of Al., Tuscaloosa, Al. 35487.

Most of the Black Belt area of Alabama was occupied by Euro-American settlers in the period 1820-1860. While some settlers were wealthy and socially prominent when they arrived, many were not. The years 1830 to 1860 were flush times in the Black Belt, and increased affluence led to an elevation in social status for settlers. This social gentrification of the rural planter produced a number of tangible expressions in the regional landscape. Among these were: 1) Place names particularly of plantations 2) polite or genteel architecture and 3) favored church denominations, specifically Presbyterian and Episcopalian. These expressions are analyzed separately.



SOCIAL SERVICE COORDINATION IN AN URBAN TRANSPORTATION SYSTEM. Dr. William R. Strong, and Andrea Priscilla Holland, Department of Geography, University of North Alabama, Florence, AL 35632-0001.

The purpose of this study is to explore the scope and magnitude of the North Alabama Transit Association (NATA) coordination efforts in transportation projects serving the elderly, handicapped and other transportation disadvantaged in the urban area. The objectives were to delimit the NATA service area, to identify the coordination activities, to analyze flexibility of routing, and to ascertain the perception of the system by the users and providers. The service region was delineated and the Social Service Agencies (SSA) were identified from information provided by Northwest Alabama Council of Local Governments. Data was collected from the SSAs, private providers and ridership through structured questionnaires and interviews. Location of the SSAs and their service areas were plotted on maps. The study focused on the urban areas of Colbert and Lauderdale Counties. Twenty-two SSAs and two private providers of transportation were identified. Interviews with SSAs, private providers and the ridership were analyzed. Evidence show that coordination of transportation is an absolute necessity in serving the needs of the client population. Not only was money a major problem, but time spent on the administration of the individual transit systems interfered with the primary activities of the SSA. Because of coordination efforts the transportation needs of the SSA's clients and others are being met more efficiently. Indeed, because of transportation coordination SSAs are now able to perform their primary duties more effectively.

COLUMBUS: A DIFFERENT PERSPECTIVE. Mary Katherine McInnish, Dept. of Geography, University of North Alabama, Florence, AL 35632-0001.

Christopher Columbus was a careful and meticulous navigator and administrator. Before his voyage to the New World in 1492, he spent years in the painstaking research of authorities, available to him, in the fields of geography, cartography, history and other related topics. Some of that information convinced Columbus that he could sail west across the ocean, and reach the fabulous wealth of the East, the Indies. In all probability, that knowledge enabled Columbus to pinpoint, at least approximately, the geographic position of the landmass he sought; the landmass which he believed to be the Indies.

ESTABLISHMENT OF THE KING SPRING WILDLIFE SANCTUARY, FLORENCE, ALABAMA. Paul Kittle, Dept. of Biology, Univ. of North Ala., Florence, AL 35632.

The King Spring Wildlife Sanctuary was established in March, 1985, by the Shoals Audubon Society. The 17-acre tract is leased from the Florence-Lauderdale Industrial Expansion Committee, Inc., and is located in an industrial park. Objectives of this project include protecting the Tuscumbia darter and other spring-adapted species, making the area accessible to the public for observation of wildlife and wildlife management techniques, and serving as a study and research site for local schools. An interpretive nature trail has been established and wildlife enhancement activities such as plantings and provision of cover have been completed.

PHYSICS AND MATHEMATICS

PREDICTING ROADWAY TEMPERATURE. Randy D. Russell  
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Montgomery, AL 36193.

Traffic accidents on icy roadways and bridges often result in financial loss and personal injury. Each year substantial monetary and human resources are devoted to the maintenance of roadways in order to minimize these losses. Improved methods of forecasting the formation of ice on roadways could lead to a better utilization of limited maintenance resources and substantial savings. This paper describes preliminary efforts to gain a better understanding of the factors influencing roadway temperature. Measurements of roadway temperature and meteorological conditions were taken at two roadway sites at three hour intervals for an entire diurnal cycle beginning at sunrise. The selected roadways were heavily traveled and located in a flat open area. A period of fine weather was chosen for the initial observations in order to study the simplest possible situation. The relative importance of radiation, turbulent heat transport, and the conduction of heat to the underlying soil were explored by comparing numerical simulations of the surface energy budget with observations. This work was partially supported by a grant from the Auburn University at Montgomery Research Grant-In-Aid Program.

ELECTRON-PHONON INTERACTION AND THEIR ROLE IN THERMAL CONDUCTION IN SEMI-CONDUCTORS. P. C. Sharma, Department of Physics, H. N. Narang, Department of Computer Science and I. K. Kothari, Department of Physics, Tuskegee University, Tuskegee, AL 36088.

The relaxation time for phonon scattering by electrons (holes) has been derived. It has been shown that only those phonons interact with electrons whose wave vector  $q$  obey the relationship,  $q < 2K_F$ ;  $K_F$  represents the Fermi wave-vector. This has been applied for the analysis of low temperature thermal conductivity of phosphorus doped germanium. This theory explains the results of temperature dependence of phonon thermal conductivity very well. The values of density of states effective mass and deformation potential constant have been determined. Those values agree well with the experimentally known values.

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POSITRONS IN ATOMIC SYSTEMS: DENSITY FUNCTIONAL THEORY OF BOUND STATES. Joseph G. Harrison, Dept. of Physics Univ. of Ala. at Birmingham, Birmingham, AL 35216.

A local density theory has been developed for bound states of a positron in an electronic system. The orbital self-interaction correction is incorporated, and electron-positron correlation effects are included by means of a local-density functional parametrization [1] of the results of a many-body calculation for a positron in an electron gas. The results for the systems  $H:e^+$ ,  $He:e^+$ , and  $Li:e^+$  are in good agreement with Hylleraas- and CI-type calculations [2].

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RELATIONSHIP BETWEEN THE CLASS ATTENDANCE AND THE FINAL COURSE GRADES. Satish M. Chandra, Dept. of Comp. Sc. & Math, William L. Lester, Academic Affairs and Ann McDonald, Dept. of Education, Tuskegee Univ., Tuskegee, AL 36088.

A study was conducted to see if a relationship existed between the class attendance and the assigned final course grades for the students taking various Mathematics and Computer Science courses at Tuskegee University. The results revealed that (i) approximately 88% (50 out of 57) of the students who missed more than 15 lecture days (approximately 30%) achieved an unsatisfactory final course grade ( a D or an E grade) ; and (ii) there is enough statistical evidence to believe that if the number of days absent is low, the final course grade achieved is significantly better. The number of days absent and the final course grade achieved were found to be negatively correlated.

GEOMETRIC INTEGRATION AND DIFFERENTIATION ON A VECTOR MANIFOLD USING CLIFFORD ALGEBRA. Garret E. Sobczyk, Dept. of Mathematics, Spring Hill College, Mobile, AL 36608.

Defining vector differentiation in terms of the limit of integration over a boundary shrinking to zero makes possible an extremely simple and intuitive proof of the Fundamental Theorem of Calculus. The classical integration theorems are special cases of this theorem.

MODELING OF THE FIBER OPTIC ARC FUSION SPLICING PROCESS.

Paul B. Ruffin, U.S. Army Missile Command, Redstone Arsenal, AL 35898.

C. Wayne Long, The BDM Corp., 2227 Drake Ave., Huntsville, AL 35805.

Walter Frost, Univ. of Tenn. Space Institute, Tullahoma, TN 37388.

An overview is given of a numerical computer model developed to analyze arc fusion splicing of glass fiber optic filaments. Physical models of electric discharge heating and glass flow occurring during the process are discussed along with their governing equations. Numerical techniques and finite difference algorithms developed to analyze the transient heat transfer along with the viscoelastic response of the glass fibers are presented. Included in the modeling are arc heating, semi-transparent glass heat transfer, free surface flows, glass coalescence, and surface tension effects. Initial results and potential applications are also discussed.

A NEW PROOF FOR LIOUVILLE THEOREM FOR HARMONIC FUNCTIONS.

Sulbha Goyal, Department of Mathematics, Tuskegee University, Tuskegee, Alabama 36088.

Two forms of Liouville theorem, strong form and weak form, are available in the literature on harmonic functions. The strong form of Liouville theorem, which one concludes via Harnack inequalities, states that any harmonic function which is bounded either above or below in all of  $n$ -space is constant. The weak form, derived by the Mean-value theorem, is that if  $u$  is harmonic for all values of  $x = (x_1, x_2, \dots, x_n)$  and is bounded above and below, then  $u$  is constant.

The purpose of this note is to give a new proof for the weak form of Liouville theorem by means of two subharmonic functionals defined on harmonic functions and Green type inequality.

GRAVITATIONAL INFALL OF A PARTICLE UNDER MODIFIED NEWTONIAN

POTENTIALS. J. Brad Bishop and John H. Young, Department of Physics, University of Alabama at Birmingham.

The modification of the Newtonian gravitational potential recently proposed by Fischbach contains a term which gives a small short-ranged repulsive contribution. A similar, but long-ranged, effect is shown to be obtainable by including field energy contributions to the Newtonian potential, in which case a quasi-linear potential results. A general expression, correct to order  $1/c^2$ , is derived for the radial infall speed of a particle under any spherically symmetric potential and is then used to compare the infall speed toward a massive compact body for the cases of the Newtonian, Fischbach, and quasi-linear potentials.

## Abstracts

GROWTH OF ZnSe BY VAPOR TRANSPORT IN AN OPEN AMPOULE. Jason M. Kinser, Elmer E. Anderson, M. K. Wu, University of Alabama in Huntsville.

Crystal growth by vapor transport in an open ampoule relies upon the forced flow of an inert gas to transport the zinc selenide vapor to the growth site. In this method several parameters become less critical than in the closed ampoule system. The products of out-gassing do not disrupt the vapor transport since the inert gas flow is the dominant process. Also, lower temperatures can be used since it is not necessary to design a vapor pressure profile as in the closed ampoule case. Crystal stoichiometry and quality can be altered easily by adjusting flow rates, cold finger design and the use of a heat exchanger.

THERMAL AND ELECTRICAL CONDUCTIVITY EFFECTS ON TEMPERATURE AND POTENTIALS IN MEDIA UNDER STEADY STATE CONDITIONS. John H. Young and J. Brad Bishop, Department of Physics, University of Alabama at Birmingham.

The relationship between temperature and potential in conducting media having temperature-dependent conductivities and conducting steady state currents has been previously discussed. Extension of those results is given to Wiedemann-Franz metals having known thermal conductivity variation with temperature, a generalized Wiedemann-Franz law and, finally, to the semi-conductor case in which the Wiedemann-Franz law is not obeyed.

SYZYGY AND TIDES OF DECEMBER 31, 1986. William J. Boardman, Div. of Mathematics and Natural Science, Birmingham-Southern College, Birmingham, AL 35254.

The abnormally high tides of New Year's Eve, 1986, exacerbated by severe weather along the Atlantic coast, were caused by a number of cyclic effects, namely, spring tides, perigee, perihelion, and the declination extremes of the moon. At the December 31 new moon, all these effects were within a phase of 0.045 from their maxima. The next comparable occurrence will not be until January 7, 2080, with a phase coincidence of 0.047.

SOME EXTREMUM PRINCIPLES IN PARABOLIC EQUATIONS.

Vinod B. Goyal, Department of Mathematics, Tuskegee University, Tuskegee, Alabama 36088

In this note several maximum and minimum principles are developed for functionals defined on the solutions of various boundary-value problems for semilinear parabolic equations in one space dimension. This leads to estimates on the growth of the solutions. These results are further extended to  $n \geq 2$  space dimensions.

INDUSTRY AND ECONOMICS

A PROFILE THE INDUSTRIAL SECTOR OF THE ECONOMY OF HUNTSVILLE, ALABAMA. Jai us G. Alexander, Dept. of Economics and Finance, and Marsha D. Griffin, Dept. of Marketing, Alabama A&M Univ., Normal, AL 35762.

Description of the U. S. economy as a "service" and/or "information" economy is now commonplace. Certainly, over the past generation, there have been tremendous changes in both the composition and geographical distribution of economic activities. With all the emphasis placed on the evolution of the U. S. economy into its "post-industrial" stage, however, it is important to recognize that the industrial base is still quite significant, even if no longer dominant. There are a number of more or less constant reminders of the significance attached to our industrial sector. Three of the most important--and increasingly visible--indicators are: 1) inter-area competition for new or relocating industrial plants; 2) concern with and proposed legislation relating to plant closings; and 3) protectionist sentiment with respect to foreign (especially manufactured) goods. Against this background, Alexander and Griffin present a quantitative profile of the industrial sector of the Huntsville economy. Using information from the 1986-1987 INDUSTRIAL DIRECTORY published by the Huntsville/Madison County Chamber of Commerce, the authors present a breakdown of firms by: 1) number of employees; 2) sector (manufacturing and allied industries vs. manufacturers' representatives); headquarters' location; 4) year established (age distribution); and 5) SIC code. Given the relative success of the Huntsville economy in recent years, this sort of information may be useful to business and political leaders in other cities who may view Huntsville as a model to be learned from. Furthermore, it should have relevance for Huntsville's leaders as they engage in industrial recruitment in the short run and as they plan for continued long-run development.

PRODUCT POSITIONING: THE DECISION MAKING STRATEGY MOST CRITICAL TO OVERALL BUSINESS SUCCESS. James W. Busbin, Department of MGT/MKT, University of Alabama in Huntsville, Huntsville, AL 35899.

Consumers typically rely upon several salient criteria by which they compare two or more competing products. These evaluative criteria are the consumer's explanation to themselves of expected product performance regarding certain product features they feel important. Thus, in their minds consumers relatively position and compare alternative products regarding product performance traits as a process of making a choice. Understanding this psychological process of consumer product positioning is critical to business success. Steps in the strategical use of product positioning are: (1) Identify the salient criteria being used by members of your market segment to evaluate your product category, (2) ascertain the ranking the consumers are giving to competitive products relative to each criteria, and (3) study the resulting groupings as to where you should most advantageously attempt to position your product.

## Abstracts

RETAIL MARKET STRUCTURE FOR FISH AND SEAFOOD PRODUCTS IN EAST-CENTRAL ALABAMA. Carole R. Engle, Dept. of Economics, Auburn University at Montgomery, Montgomery, AL., 36193-0401. L. U. Hatch and S. Swinton, Dept. of Agricultural Economics, Auburn University, AL. 36849.

National per capita fish and seafood consumption is expanding in response to health concerns related to consumption of red meat. A stratified random sample of retail grocery stores and supermarkets in 13 counties in East-Central Alabama and West-Central Georgia was surveyed to document selected components of local demand for fish and seafood. Data were collected on prices, volumes, product form, seasonality of demand, promotional tactics, and potential improvements in seafood marketing. Of the 125 grocery stores contacted, 20% handled seafood products, while 94% of the 32 supermarkets did. The important seafood products with greatest volumes and gross retail sales were: catfish, ocean perch, whiting, mullet, oysters and shrimp. Catfish was the most widely handled fresh fish product whereas ocean perch was the most commonly purchased frozen product. Rural grocery stores tended to offer less variety and generally handled frozen whiting, mullet and perch as well as occasional salted fish. Small urban inner-city supermarkets also carried fresh dressed catfish and oysters. This segment of the market tended to expect declining future sales of seafood. Urban and suburban supermarkets with middle-class clientele sold larger volumes and offered a wider variety of fresh and frozen seafood products. This market segment expected increasing future sales and planned to expand their seafood marketing efforts. Thus, the increase in per capita seafood consumption nationwide appears to be concentrated in higher-income urban and suburban markets.

Some Application of Cost Accounting in Commercial Banks  
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Cost Accounting has become a specialized field of accounting which can provide quantitative information that is useful in planning activities, evaluating performance, controlling costs, and making routine and strategic decisions. Commercial banks are among the various service organizations which have started instituting cost accounting systems.

Some of the possible areas of application of cost accounting in commercial banks include the use of cost information in (1) planning for bankwide or specific activities; (2) evaluating the profitability of different types of deposits, loans, and investments; (3) appraising the performance of divisions, branches, or departments; (4) determining and controlling the different types of bank costs and expenses; and (5) deciding among alternative courses of action.

The consideration of all aspects of cost accounting which may be applicable in commercial banks is beyond the scope of this paper. Accordingly, only some techniques which are deemed to be relevant and most useful are selected and presented in the paper. The techniques discussed include (1) cost allocation, (2) cost-volume-profit analysis, (3) responsibility accounting and (4) standard costing.

SOCIAL MARKETING: THE WET-DRY ISSUE. Donald W. Caudill, Department of Marketing, University of North Alabama, Florence, AL 35632-0001.

Kotler and Zaltman (1971) first introduced the term "social marketing" for the "efforts of organized groups to countermarket undesirable social ideas or practices, or to promote desirable ideas or practices." The authors used as examples campaigns to reduce smoking, alcoholism, and drug usage. In recent years, however, organizations have taken a greater interest in this area applying the knowledge to such endeavors as pornography and package-liquor referendums (especially in the South).

The purpose of this research was to predict one group's (Citizens Against Drug Abuse) likelihood of success in defeating a liquor referendum in a college town of approximately 10,000 residents. The group applied principles of marketing to the task concluding with a random telephone survey of voters and nonvoters immediately prior to the vote.

Of the 139 respondents contacted, 101 were registered voters and planned to vote on the issue. The research found that while 40 percent of the respondents did consume alcoholic beverages, only 36 percent planned to vote for the sale of liquor. Moreover, voting in favor of the issue was significantly affected by demographic variables.

PATIENT ATTITUDES TOWARD MEDICAL CARE: A COMPARISON OF URGENT CARE ALTERNATIVES. Gerald Crawford, Professor of Marketing, and Howard E. Hopwood, Graduate Student, School of Business, University of North Alabama, Florence, AL 35632

This research project centers on three separate surveys involving the delivery of medical care in North Alabama cities. Two of the research efforts examined former patients' attitudes toward hospital emergency room care, while the third survey employed similar instruments to measure former patients' attitudes toward a reasonably new freestanding emergency medical clinic, located in the Muscle Shoals Area of North Alabama. In one study it was shown that there was a good deal of room for improvement in outpatient medical care. Thirty-one percent of those interviewed had "good" comments, while 69 percent had negative or indifferent comments. In another study, there were 34 percent "good" comments, while 66 percent were negative or indifferent. In a third study involving a freestanding emergency medical clinic, more than 90 percent of the comments were favorable. The general advantages cited were prompt service, convenient location, reasonable cost, friendly staff, better doctors, and nice facilities. Conclusions drawn include the idea that a marketing approach to medical care can result in higher levels of patient satisfaction.



## Abstracts

ECONOMIC DEVELOPMENT AND THE FUTURE OF ALABAMA. Lawrence W. Lovik, Holder of the Adams-Bibby Chair of Free Enterprise and Mac R. Holmes, Research Professor of Business and Economics, Sorrell College of Business, Troy State Univ., Troy, AL 36082

There have been vast changes in political economy during the past quarter of a century. Macroeconomic misfeasance often resulted in localized economic dyspepsia or worse. The march of ideas has led to new paradigms, and the progression of historical events have resulted in important alterations in the business environment. We are now in a global marketplace, and economic myopia must be avoided. To become more competitive there must be a concerted effort by responsible leadership from government, education, and private enterprise. This is not a call for a form of centralized state planning wherein government targets winners and losers. That is best left to the market and the profit and loss calculus or else new ideas will be smothered in the bud and inefficiencies will erode both actual and potential wealth creating activities and attitudes. In this paper the structures of the Alabama and the national economies are considered. Economic sectors are ranked according to income and employment generating ability. An input-output model, developed for Alabama by the Center for Business and Economic Research at Troy State University, is utilized to estimate earnings and employment multipliers. The use of multipliers provides a ranking of sectors according to their relative marginal impacts on total earnings and employment for the state. A framework is developed for evaluating options for the medium-term outlook. Attention is given to the requisite conditions for economic growth and development. An improved state image must be more than cosmetic. It must be substantive to have the needed lasting effect.

STARTING A BUSINESS IN YOUR HOME. Frederick A. Viohl, College of Business, Troy State University, Troy, AL 36082

This is the age of the entrepreneur. The modern entrepreneur who operates a business out of his or her home is very much like the entrepreneur who operates a business at some commercial location. They appear to share more than the desire to make more money. They wish to run their own business--with all the attached exhilarations and risks. These home businesses include: direct sales (multi-level marketing) opportunities; craft and hobby related businesses; services; and catalogue publications marketing. Home office tax breaks coupled with other tax reduction opportunities involving automobile expenses and depreciation, entertainment expenses, telephone expenses, office furniture expenses, etc., have offered the home business entrepreneurs many of the same benefits enjoyed by large corporations. The home based venture faces the same business requirements of large organizations when it comes to accounting and finance, marketing and general management. Basic advice includes; obtain a job in the same kind of operation you are interested in. One can learn more in a few months of work in a successful concern than you can in two years of blundering on one's own. This experience will save a person from all kinds of expensive and often fatal errors.

MARKETING RESEARCH FOR NONPROFIT SERVICE ORGANIZATIONS. Donald W. Caudill and Keith Absher, Dept. of Marketing, University of North Alabama, Florence, AL 35632-0001.

The financial feasibility of nonprofit service organizations has been an highly debated issue in recent years. Very little empirical and good qualitative research has been conducted which relates directly to the marketing of such concerns. Therefore, the purpose of this study is to share one nonprofit service organization's (a county fair) successful method for surveying its market.

A 70-question research instrument was administered in a typical Southern rural county of approximately 55,000. A random telephone sample of county residents was taken. The questions in the survey were a mixture of significant and unimportant (i.e., I like cotton candy) items to keep the respondent interested. Further, some questions were worded negatively so as to receive a more accurate overall response.

Finally, the results of the survey were analyzed with respect to the product (services: music, beauty contests, rides, games and exhibits), price (admission, rides, games, parking, food and special events), promotion (advertising, publicity, sales promotion, personal selling, and public relations), place (location, facilities, and parking). Demographics with respect to sex, age, race, income, marital status, education, occupation, dwelling type, mobility and number of fairs attended were evaluated.

The utilization of a survey instrument such as this one is simple and inexpensive, yet can be very effective in helping nonprofit service organizations prosper.

ECONOMIST AS EXPERT WITNESS. Philip Gregorowicz, Department of Economics, Auburn University at Montgomery, Montgomery, AL 36193-0401.

Economists are increasingly utilized to estimate the economic damages and lost future earnings of individuals who suffer physical impairments. The purpose of this paper is to review and analyze the procedures generally used by economists in estimating the value of future lost income of individuals who have suffered either complete or practical loss of access to labor markets. Further, some practical insights are provided to improve the effectiveness of economists who testify as expert witnesses in courtroom settings. Estimating the economic value of an individual involves the accumulation and analysis of information about an individual's personal characteristics, employment history and future labor market opportunities. This analysis critically depends on the choice of several assumptions reviewed in this paper. These include: expected work life, future real and nominal wages increases, the expected inflation rate and appropriate discount rate to use in the calculations. Alternative procedure are available in making these estimates. In addition, the appropriateness of integrating the 'informed judgements' of noneconomists, such as vocational specialists, is discussed in this paper.

POST DEREGULATORY MARKETING PRACTICES OF ALABAMA ACCOUNTING PROFESSIONALS: AN HISTORICAL REVIEW AND FIELD SURVEY. James W. Busbin  
Department of MGT/MKT, University of Alabama in Huntsville,  
Huntsville, AL 35899.

Until 1978, CPA firms were effectively banned from the practice of advertising by the Code of Professional Ethics issued by the American Institute of Certified Public Accountants and all other professional accountants followed suit. For a variety of reasons, the American Institute of Certified Public Accountants (AICPA) removed all restraints to CPA advertising in March, 1979.

Until this point, certified public accountants and professional accounting firms in general had been artificially restrained from fully participating in the competitive marketplace. These firms went about their business in a sheltered environment and with a submissive competitive attitude. Although the formal restraints on advertising and other assertive marketing activities have been rescinded, CPA firms have been slow to respond. This may be largely due to informal pressure to adhere to stately traditions, conservative accounting personality types and a general hesitation to embark on unfamiliar activities.

The results of a survey of Alabama accounting firms was conducted to ascertain their extent of and attitudes about marketing and advertising practices. In general, the findings were consistent with national observations; Alabama accounting firms are hesitant to advertising and unsure of its application and benefits.

ECONOMIC DEMAND FOR HEALTH CARE FOR LOW INCOME PERSONS: POLICY IMPLICATIONS FOR A BALANCED FEDERAL BUDGET. H. Dean Moberly,  
Department of Economics, Auburn University at Montgomery, Montgomery, AL. 36193-0401.

U.S. health care cost represents 11 percent of total gross national product (GNP). These costs are projected to continue increasing in the future owing to physicians having to perform more (and more costly) tests in their practice to prevent malpractice lawsuits. Inflation will continue to add to these costs. Low income persons demand the same level of health care as do those who can pay for this service. Medicare and Medicaid programs have been (since 1965) set up by the Federal government to aid low income persons in affording health care. This spending has increased every year and adds to the annual Federal deficit. This study explores the economic demand for health care for low income persons. Since a health care demand curve exists for low income persons, it is known that they can pay for part of their health care. Given that this is true, the implication is that government does not need to bear all the total costs for low income health care which is now the case. Government could then reduce borrowing to pay for such health care by paying only the portion of the low income health care bill that an individual or his/her family could not pay. This would require a more efficient means test, but would aid the Federal government in reducing deficit spending.

ON THE TIME VALUE OF AN INVESTMENT IN HUMAN CAPITAL: WHAT IS THE INVESTMENT VALUE OF GOING TO COLLEGE IN ALABAMA? Dennis W. Gibson, Division of Business Administration, Troy State University in Montgomery, Montgomery, AL. 36195.

There are many benefits to be derived from a college education and they range from a higher quality of life to increased earning power by virtue of the acquisition of increased talents or skills. The purpose of this paper is to explore the extent of the income differential between a high school graduate and a college graduate in terms of an investment. The investment consists of the average tuition, board and room for an Alabama College plus the opportunity cost of lost income as a full-time student for four years. There are a number of commonly accepted financial management techniques for the evaluation of an investment. Two of the more common techniques for discounting anticipated cash flows are the Net Present Value (NPV) and Internal Rate of Return (IRR). This investment in human capital in the form of additional years of education should be undertaken as long as the rate of return, in terms of increased earning power, exceeds the market rate of interest. The data indicates that the income differential is decreasing, college costs are increasing and investment yields in excess of 12.5% make a four year full-time college investment less than an optimum investment.

UTILIZATION OF ADVERTISING AGENCIES BY PROFESSIONAL INDIVIDUALS. Keith Absher and Gerald Crawford, Dept. of Marketing, University of North Alabama, Florence, AL 35632-0001.

In 1977, the Supreme Court banned legal associations from prohibiting member lawyers from advertising. This decision has now been interpreted to cover other professionals, including architects, accountants, dentists, and medical doctors. Now that these professionals are allowed to advertise, it would be useful to conduct a study to: (1) Examine the extent to which professionals are using advertising agencies, (2) Identify trends in professional attitudes toward advertising at this time, and (3) Obtain advertising agencies' viewpoints toward professional accounts and copy/media approaches.

This study is based on a telephone interview of 81 advertising agencies. Agencies reported that professional individuals using advertising were younger than the general population of professionals and were less well-established.

Media analysis reveals that print ads tend to dominate professional advertising. Agencies report that lower cost is the reason for this preference, but reported that shift toward broadcast media is expected in the future as competition becomes more intense. There was some indication that direct mail was preferred to other forms of media because it was hidden from competitors.

## Abstracts

GETTING INTO PRINT. Macon Wilbourn, Department of Accounting and Finance, Auburn University at Montgomery, Montgomery, AL 36193.

Academe has truly become a "publish or perish" world. Years ago we talked about the concept -- now it has become a reality. We are primarily measured, as professionals, by the length of our publications list. So let's get down to basics: How does the concept apply to higher education in Alabama? This paper addresses the following major ideas:

Tenure and promotion: Publications v other factors;

What constitutes a "publication";

How publications are assessed for merit;

Ways to increase the publications list; and

Common mistakes to avoid.

A STUDY TO DETERMINE THE PERCEPTION AND EXTENT OF EMPLOYER SUPPORT FOR PROFESSIONAL DEVELOPMENT ACTIVITIES BY GOVERNMENTAL ACCOUNTANTS AND AUDITORS. Edward G. Kamnikar, Dept. of Accounting, Troy State University, Troy, AL 36082. Judith A. Kamnikar, Dept. of Accounting and Finance, Auburn University at Montgomery, Montgomery, AL 36193.

The purpose of this paper is to determine the perception and extent of employer support for professional development activities by governmental accountants and auditors in the State of Alabama. A questionnaire study was conducted to obtain the necessary data from accountants and auditors working at the city, county, and state levels in Alabama. Descriptive statistics have been summarized for each governmental area and in total. Although there was some variation in the perception of employer support between areas, there was overwhelming agreement by all governmental accountants and auditors that professional development activities were necessary to maintain professional competency for their respective jobs.

## Abstracts

PSYCHOMETRIC CHARACTERISTICS OF A PRE-EMPLOYMENT SCREENING DEVICE. William I. Sauser, Jr., Department of Management, Auburn University at Montgomery, AL 36193. Jeffrey S. Hornsby and Philip G. Benson, Department of Psychology, Auburn University, AL 36197.

Compu-Scan is a pre-employment screening device which considers a job applicant's potential for such undesirable behaviors as substance abuse, theft, and violation of company policy to assign an overall risk score. Data provided by a private security firm included 445 completed Compu-Scans; 48 persons had also undergone a pre-employment polygraph examination. A coefficient alpha of .84 was obtained for Compu-Scan, suggesting that it consistently measures a single construct, "employment risk." Furthermore, risk scores from Compu-Scan correlated .44 ( $p = .004$ ) with those from the polygraph, providing some evidence of construct validity.

PRODUCT POSITIONING FOR PRIVATE PRACTICE PHYSICIANS: THE NEED FOR CONSULTANT VOICE CHANGES. Robert L. Sanders, Dept. of Marketing, Management, and Economics, Troy State University, Troy, AL 36082.

Since the Bates versus Arizona Bar case was decided in 1977, the marketing of professional services has seen many changes. One area of considerable change has been that of the private practice of medicine. In this paper the author attempts to compare and contrast, at five-year intervals for 1972, 1977, 1982 and 1987, how marketing management consulting advice has changed at these intervals for private practice physicians. The conclusion includes a list of threats and opportunities for private practice physicians which must be considered in the future advice given.

ALABAMA'S VOLUNTEER FIREMEN REVISITED. Clarence A. Spencer, Jr. School of Commerce and Business Administration, University of Alabama, Tuscaloosa, AL 35487. Clarence A. Spencer, Jr.

The history of the development of volunteer firefighting companies is traced from their early beginnings in England through their transplantation to colonial Philadelphia with their spread to Alabama in the early 1800's down to their modern counterparts in the state today. Modern fire prevention programs are compared to Mobile's early attempts at fire prevention and problems encountered by early fire companies in Alabama with solutions attempted are compared and contrasted with similar presentday problems and solutions employed by volunteer firefighting companies in the state.

SCIENCE EDUCATION

NEEDS ASSESSMENT OF ALABAMA SECONDARY SCIENCE TEACHERS.  
William E. Paired , Department of Curriculum & Teaching,  
Auburn University, Auburn, Ala. 36849-3501

One of the most diverse and complex groups of teachers are those who teach science at the secondary level. These teachers encounter a wide variety of student abilities, laboratory facilities, administrative support, budgetary restrictions, etc. which impact their job performance and needs for training. The design of effective inservice training requires a sensitivity to the needs of active classroom teachers. Without careful advance needs assessment, results are likely to disappoint both teachers and support personnel. This presentation will describe a 70-item needs assessment instrument designed to obtain a profile of the needs of active science teachers in Alabama. The instrument was pilot tested in November, 1986 as part of a science olympiad mailing to secondary science teachers around the state. Results of the pilot test will be presented for discussion. A proposal for full-scale use of the instrument is pending. Implications of survey results for planning at the local, regional and state levels will also be discussed. Comparison of the needs of Alabama science teachers with those in other states which have conducted similar assessments will be summarized. Sharing of this database with planning agencies and the eleven regional inservice centers in Alabama is part of the expected outcomes from the survey.

A PROBLEM BASED APPROACH TO TEACHING HIGH SCHOOL ANATOMY AND PHYSIOLOGY. Larry Rainey, Elaine Dumas, College of Community Health Sciences, University of Alabama, Tuscaloosa, Alabama 35487.

Problem Based Learning is an exciting, challenging and rewarding approach to acquiring new information. A primary goal of this approach is the development of skills in self-directed learning and problem solving. These skills enable the student to learn basic concepts of anatomy and physiology and can be applied to other areas of study. Scientific principles from biology, chemistry, physics, mathematics, and the social sciences are incorporated into the course. In addition, expository writing skills are developed as scientific and human problems are addressed. Additional emphasis is placed on the interaction with community agencies and resource personnel.

This paper discusses the implementation of problem-based learning in the anatomy and physiology classrooms of five rural high schools in West Alabama.

## Abstracts

CRUCIAL CONCERNS AND PROMISING IDEAS IN SCIENCE EDUCATION. Robert E. Rowsey, Department of Curriculum and Teaching, Auburn University, Auburn, AL 36849.

Forty-five science teachers from throughout Alabama and West Central Georgia, who participated in a National Science Foundation sponsored Summer Institute located on the Auburn University Campus during Summer quarter 1985, were asked to enumerate what they considered to be the most crucial concerns and promising ideas facing science education at the secondary level, grades seven through twelve. The four most often mentioned concerns listed in order of importance are as follows: 1st. Lack of qualified science teachers (36 percent of the teachers indicated this). 2nd. Decreasing number of students enrolled in elective science courses (29%). 3rd. The negative image of science teachers as viewed by the public (20%). 4th. Much of the present curriculum does not meet the needs, interests and abilities of students (18%). Four of the most mentioned promising ideas relative to the future of science education are: 1st. The use of the microcomputer in classrooms and laboratories (38%). 2nd. The use of VCR's in the classroom (24%). 3rd. The implementation of a science curriculum based on the interaction of science, technology and society (22%). 4th. More federal support for inservice science teachers (20%).

POLARIZED LIGHT MICROSCOPY FOR THE HIGH SCHOOL LABORATORY. John E. Phillips, Jr., and Thomas Pierce, University of North Alabama Occupational and Environmental Health Laboratory, Florence, AL 35632.

Polarized Light Microscopy (PLM) finds numerous applications in mineralogy, biology, chemistry, and other disciplines. Given the emergence of microscopic techniques for a growing number of occupational health applications, high school students should develop an understanding of the principles of PLM. Asbestos identification is a pressing national concern that can allow a student to become familiar with such concepts and their application. However, purchase of polarized light microscopes can be quite expensive for a high school. Fortunately, a plain light microscope, similar to that found in a biology lab, can be easily converted to a polarized light microscope at a very low cost.



REFERENCE FRAME SHIFTING: A STIMULATION TO SCIENTIFIC THINKING.  
Ernest D. Riggsby, Patricia Spano (deceased), Columbus (GA) College,  
Lyn Riggsby, Arnold Junior High School, Columbus, GA 31904.

From two planning sessions, the research team generated a series of thought explorations in which students were expected to manipulate circumstances in which the ordinary reference frame had been shifted to less familiar applications. The team was composed of a science educator, a professor of English, and a junior high school student. The team members were individually knowledgeable about reference frame but in different areas of interest and levels of difficulty. As a team, the interaction was capitalized upon. The posers which came from the brainstorming sessions were later presented to a limited number of subjects selected from fifth and sixth grade science students in the Muscogee County Georgia public schools. Before the end of the efforts, several students had gained enough skill to contribute shifted-reference-frame problems of their own.

SOCIAL SCIENCES

BUREAUCRATIC LEADERSHIP AND SOCIAL DEVELOPMENT IN DIVERSE ENVIRONMENTAL CONTEXTS: A PROPOSITIONAL PAPER. J. B. Jimmeh, Dept. of Political Science, Tuskegee University, Tuskegee, AL 36089.

Formulating and managing public policy for social development within environmental contexts of scarcity, political instability, and economic dependency remains the perennial task for bureaucratic leadership in less developing countries (LDCs). Despite much theoretical attention and the transfer of resources to LDCs, the empirical development experience in Africa is generally retrogressive. In analyzing or undertaking this task from an ecological perspective, it is basically assumed that bureaucracy interacts with diverse environments. There are exchanges and mutual effects. Consequently, given their pivotal positions/roles, it is expected that bureaucrats negotiate or mediate means and ends under changing situations. In the process, bureaucrats may be oriented primarily toward different leadership styles: "Innovator, Developer, Maintainer, Figurehead". It is the central proposition here that the "Maintainer" style of bureaucratic leadership in LDCs is a critical contributing factor to this general state of underdevelopment.

## Abstracts

BEHAVIORAL-BASED CLASSIFICATION FOR NEW GENERATION JAILS. William E. Osterhoff, Dept. of Justice and Public Safety, Auburn University at Montgomery, AL 36193.

The concept of "new generation" jails represents the state of the art in detention facility management and design. Inmate management in new generation jails involves direct supervision of inmates instead of indirect or intermittent supervision which is used in traditional jails. The new generation jail concept is based on the assumption that most offenders will behave rationally when housed in a secure and safe environment in which a staff member is constantly present. Inmate control is achieved through interpersonal management, leadership, and communication skills of the staff, instead of relying on traditional architectural restraints. Proper classification of inmates is critical for successful inmate control in new generation jails. It is suggested that inmate classification can be based on observed inmate behavior and need for individual supervision instead of traditional classification criteria. Inmates with special management needs and inmates unable or unwilling to behave rationally would be classified accordingly and would be housed separately from the general inmate population. It is also proposed that each of the correctional staff be classified based on observed supervisory behavior and style of inmate management. Styles of inmate management would be classified along a continuum including a directive or authoritative style, a collaborative or facilitative style, and a laissez faire or democratic style of inmate supervision. The inmates and staff would be matched and would be assigned to housing units according to their classifications. Inmates would be reclassified when their behaviors suggested changes in supervisory requirements.

REDUCING AGGRESSIVE BEHAVIOR THROUGH VOCAL AND VISUAL ANTECEDENTS. Judd A. Katz and Susan B. Meers, Department of Psychology, Auburn University at Montgomery, Montgomery, Alabama 36193-0401.

A twenty-three (23) year old institutionalized retarded male was the subject of a multiple baseline research project to reduce physical and verbal aggression. The project used vocal and written antecedents and consequential stimuli in an effort to decrease maladaptive fighting and swearing behavior. The investigators not only provided vocal instruction on how to avoid fighting and swearing, but they provided brief written instruction to which the client referred, when the investigators were not present at the institution. Generalization of appropriate behavior was promoted by varying the location of the therapy sessions and rotating assistant staff therapists. Due to the significant decrease in both of the aggressive behaviors, the client was allowed to move from dormitory residence to transitional housing outside of the institution to prepare for group home life.

## Abstracts

### INTERORGANIZATIONAL NETWORK DEVELOPMENT IN STATE AGENCIES.

James A. Johnson, Department of Political Science, Memphis State University, Memphis, TN 38152

In unstable, changing environments we have seen that organizations become more interdependent and seek to form interorganizational relationships. This is especially true in public sector and human service agencies where financial and human resources are becoming more and more scarce. Enhancing these relationships and making them more effective and productive is where interorganizational network development has promise.

Interorganizational network development can be defined as planned change efforts which seek to facilitate the development of relations among organizations. It is very similar to organization development in the application of behavioral science technologies yet it differs due to the context and objectives of networks. Networks are under-organized systems and the development of them requires the following: 1) Improved collective performance; 2) Increased member satisfaction and goal fulfillment; and 3) Enhancement of leadership position.

There are clearly identified stages of development reported in the literature. In a recent interagency network development program in Florida we were able to delineate these stages and to improve resource and information sharing among the participating agencies. This program of research and development provides a model by which other state government systems such as Alabama could build and maintain productive interagency linkages. As Harlan Cleveland has stated, "the future is horizontal" and we are increasingly having to go outside of our own organizations to accomplish the important tasks.

### THE EFFECTS OF CAFFEINE ON THE ATTENTION SPAN AND ALERTNESS OF FOURTH-GRADE CHILDREN. Frances A. Breslin, Department of Psychology, Univ. of Alabama., University, AL 35486.

Caffeine, probably the most ubiquitous drug in our society, is readily available to children in the form of soft drinks, chocolate milk, and tea. In spite of caffeine's prevalence, its effects on children are not well understood because of confounding variables in earlier studies. Sixteen non-hyperactive fourth grade children participated in a study examining the effects of caffeine on children's alertness and attention span. Each day the subjects were pretested; ingested capsules containing 0, 50, or 100 mg of caffeine; waited 30 minutes; and were posttested. The alertness measure required the children to become alert after a tone and to identify letter pairs as the same or different. The attention span tasks involved both fixed and varied rate continuous performance tasks. MANOVA analyses indicated that caffeine affected attention span but not alertness,  $p < .05$ . These results are important because they indicate that relatively small doses of caffeine (50 mg), the amount in one 12 ounce can of caffeinated soft drink, affect attention span. Additionally, differing doses of caffeine appear to be beneficial for differing tasks. Finally, these quantities of caffeine have no measurable effect on alertness.

## Abstracts

THE USE OF POSITIVE REINFORCEMENT (DRO) TO REDUCE AGGRESSIVE BEHAVIOR IN PRISON. Mike Haynes, Elbert Rush, Judd Katz, Department of Psychology, Auburn University at Montgomery, Montgomery, Alabama 36193-0401.

The subject in this investigation is a twenty-year old male who is currently serving a sentence of 40 years for Robbery I (two counts). His record reveals a long-standing history of severe behavioral problems, substance abuse, and involvement in anti-social activities. It is also recorded that he displays intense anger and a lack of emotional control as demonstrated by his volatile, aggressive behavior. This behavior was demonstrated when the subject was escorted from his cell to a prison activity, e.g., recreation, showers, or medical evaluations. An A-B design was selected to monitor his behavior. A one-month baseline period was used to observe the aggressive behavior without intervention; after baseline, a one-month intervention followed where the subject was given DRO reinforcement for non-aggressive behavior. The reinforcer consisted of allowing the subject phone-call privileges immediately after proper social behavior without aggression. When comparing baseline behavior with intervention, the subject's aggressive behavior was reduced by 60%, which was considered a noticeable and significant decrease in his aggression. Since the project was conducted by correctional officers, it allows a good opportunity for the generalization of non-aggressive social behavior throughout the institution.

Black Political Empowerment In Hancock County, Georgia.  
Lawrence J. Hanks, Department of Political Science, Tuskegee  
University, Tuskegee, AL 36083

There were no black elected officials in Hancock County in 1964. By 1974, 17 of 18 public elected officials in Hancock were black. This political transformation did not occur by chance--it was the result of an organized effort to gain black political empowerment. This paper is an explication of how this empowerment was achieved. Hancock's black political empowerment was the result of five major factors: (1) Hancock's mild political climate was conducive to political activism; (2) initially their overwhelming numbers gave them the opportunity to gain political offices with only half of their numbers registered; (3) the leadership was able to secure the resources to combat fear of violence and economic intimidation; (4) they were able to provide material incentives which spurred optimal levels of black voting and (5) the empowerment effort created a wide racial cleavage which facilitated high levels of black racial bloc voting.

## Abstracts

BIRMINGHAM AT ODDS WITH ITS POLITICAL REGIONS. David W. Sink, Dept. of Political Science and Public Affairs, Univ. of Ala. at Birmingham, 35294.

The Birmingham metropolitan area, which represents twenty-two percent of the state's population, has experienced a long and often-times contentious relationship with its political regions. In similar fashion, the city of Birmingham itself frequently finds itself at odds with its surrounding hinterland. This paper discusses Birmingham in its political context. It is not argued that this relationship is unique among American cities; large cities which differ greatly from their surroundings, especially those in historically rural states, appear to experience a similar brand of conflict. However, it is argued that Birmingham exhibits a kind of political microculture which differs from the surrounding traditional populist values and may well lead to such noticeable political differences.

PSYCHOSOCIAL INFLUENCES FOLLOWING CORONARY ARTERY BYPASS GRAFT SURGERY.  
Naresh Kaushik, University of Alabama at Birmingham.

Coronary artery bypass graft surgery(CABG) is now an established therapy for the treatment of heart disease,the leading cause of death in the United States. Research on the effectiveness of CABG has shown that most CABG patients have low rates of return to work despite improved cardiac functioning. This paper addresses the relationship between employment status and psychosocial influences following coronary artery bypass graft surgery. 105 patients,eightyone men and twenty four women; who received CABG during 1984-85 were interviewed during the hospitalization(base line) and at 3 months, 6 months, and 12 months post discharge to determine their psychosocial status and clinical outcomes. Patients who reported a large network of social support were less likely to be depressed, had higher perceived health status, and were more likely to return to work. Data suggests psychosocial status influences recovery following coronary artery bypass graft surgery.

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WOMEN LEADERS IN AMERICAN POLITICS: A TYPOLOGY OF CAREER DEVELOPMENT.  
V. Lynne Windham, Dept. of Political Science & Public Affairs, Univ. of Al. at Birmingham, Univ. Station, Birmingham, AL. 35294

The career development of women leaders in American Politics is an interesting study for young women who aspire to a still deviant sex-role career in politics. Four nationally known, prominent female leaders in American Politics are considered in relation to their leadership qualities, backgrounds, and career developments. A typology of the career developments of Eleanor Roosevelt, Barbara Jordan, Jeane J. Kirkpatrick, and Geraldine Ferraro is explored.

## Abstracts

IDENTICAL TWINS IN SPORTS -- A CASE STUDY, A. Tan,  
Department of Physics, Alabama A&M University, Normal, AL 35762.

The college and professional basketball careers of the Van Arsdale twins are studied by examining the numbers of games played, field goals attempted and made, free throws attempted and made, rebounds, assists, fouls and points scored. It is found that whereas the numbers for individual games show very little correlation, the aggregate numbers over a season betray a very high correlation. When the twins played in the same team in college, the data indicate a correlation coefficient as high as .98 and even when they played for different teams in the professional league, the correlation coefficients were still close to an amazing .97. This remarkable correlation indicates that heredity was the overwhelming factor in player performance in this case.

Critical Analysis of the Theory of Black Empowerment in America.  
Walter S. Williams and Lawrence J. Hanks, Dept. of Political Science,  
Tuskegee University, Tuskegee, Ala. 36083

This paper will examine the theory that Black Political Empowerment will be achieved once Black people gain access to the ballot and exercise this right to elect other Blacks to office. Also, the theory of Black Political Empowerment asserts that once Blacks are elected, they will enact positive public policy which will serve to increase the socio-economic status of the Black community.

## HEALTH SCIENCES

CAUSES AND PREVENTION OF FALLS IN THE ELDERLY. M. L. Collins, P. Liles, J. Neille, and R.E. Pieroni, College of Community Health Sciences, Univ. of Ala., Tuscaloosa, AL 35487.

Repeated falling has been shown to be a leading cause of morbidity in the elderly, being responsible for about half their accidental injuries. Of elderly in the community, one-third reported having fallen during the previous year. The mere fear of falling can lead to a sedentary existence with diminished quality of life. The institutionalized elderly have a dramatically higher incidence of falls, some of which can result in severe trauma, e.g. fractures, and premature death. We have been developing "Accidental Fall Assessment Forms" for use in a rehabilitation unit serving mainly recent stroke and post-operative orthopedic patients, and a large chronic-care nursing home. These forms evaluate both intrinsic and extrinsic risk factors for falling. Intrinsic factors include age-related balance impairment, e.g. possible orthostatic hypotension, drug effects or interactions, and decreased visual and hearing acuity. Extrinsic risk factors for falling include physical hazards, e.g. slippery floors, and obstacles; hazards of personal living which might include poorly adjusted eyeglasses, and improper clothing or footwear. By fully documenting the circumstances surrounding falling episodes at our institutions we are attempting to diminish such occurrences to the extent possible with a resultant potential decrease in morbidity.

PROPERTIES OF ANION CHANNELS IN VASCULAR SMOOTH MUSCLE. Roger T. Worrell, Richard L. Shoemaker, Wells W. Magargal, Depts. of Physiology and Biophysics, Medicine, UAB, Birmingham, Al. 35294.

Patch clamp techniques were employed to study single anion channels in cultured aortic Vascular Smooth Muscle (VSM) cells from Wistar-Kyoto (WKY, normotensive) and Spontaneous Hypertensive Rats (SHR). Three types of anionic channel activity could be demonstrated using inside-out membrane patches. 1) The "Positive Off" type channels produced an outward current and inactivated in a time dependent manner with a depolarizing voltage (from the reversal potential,  $E_{Cl}$ ). This inactivation was voltage step dependent; as  $\Delta V$  increased, from  $E_{Cl}$ , the peak current increased and the closing time constant (as determined by the stepwise closure) decreased. 2) The "Negative Off" type channels produced an inward current and inactivated in a time dependent manner with a hyperpolarizing voltage step. The inactivation showed the same voltage step dependence as the "Positive Off" type channels. 3) The  $[Ca^{++}]_i$  inactivated anionic channel was more active at lower  $[Ca^{++}]_i$ , showing a decrease in activity as  $[Ca^{++}]_i$  increased. This channel exhibited flickering type kinetics with a conductance of 17 pS. Chloride was the principle current carrier in all the above channel types. These channels could act to help restore the membrane potential to resting level. We found no statistical difference between WKY and SHR with respect to these anion channels. Supported by NIH RO1 HL35502.

STAFF MEMBERS' ABILITY TO RECOGNIZE COMMON HEALTH PROBLEMS OF CHILDREN IN DAY CARE CENTERS. Janet G. Alexander and Janice L. Vincent, School of Nursing, U.A.B., University Station, Birmingham, AL 35294.

It is estimated by 1990 that the number of children with working mothers will increase from 7.1 million to 10.5 million ("Changing Childhood Disease, 1984; Smith, 1979). The social changes that have encouraged the development of day care centers have also forced working parents to place their children with mild illness at the centers instead of being kept home. Once there, these children can readily transmit their illness. The purpose of the study was to ascertain if staff members were confident in their ability to recognize common health problems of children in day care centers. Forty day care centers out of a total of 162 were randomly selected from four geographic areas within a county in Alabama. Questionnaires were distributed to 370 staff members and 40 directors. Sixty-eight percent (68%) of the staff members and 100 percent of the directors completed and returned the questionnaires. Statistical analysis is presently being completed. It is anticipated that the study will enable the researchers to identify health educational needs of the majority of staff members in the day care centers.

DESIGN OF N-ACYL-N-ARYLGLYCINES AS PROBES OF THE INHIBITOR BINDING SITE OF ALDOSE REDUCTASE. Blake E. Swearingen and Jack DeRuiter, Department of Pharmacal Sciences, School of Pharmacy, Auburn, University, AL 36849.

In an earlier study, a number of 2-oxoquinoline-1-acetic acids were synthesized as potential probes of the inhibitor binding site of aldose reductase. In the rat lens assay, these compounds are relatively potent inhibitors of this enzyme with IC<sub>50</sub>s of 5 to 0.5  $\mu$ M. Structure-activity studies revealed that the unsubstituted 1-acetic acid moiety is required for optimal aldose reductase inhibitory activity and that aromatic ring substituents as well as the pyridone ring present in the 2-oxoquinoline-1-acetic acids contribute significantly toward activity. To further explore the contribution of the pyridone ring toward activity, a number of N-acetyl and N-benzoyl-N-arylglycines were synthesized and tested; these compounds represent ring-opened derivatives of the quinolines which retain all the functionality except the quinoline C-3-C-4 double bond. In the rat lens assay, the N-acetyl derivatives are significantly less potent than the 2-oxoquinolines with ICs of 10 to 150  $\mu$ M. The N-benzoyl-N-arylglycines, however, are approximately as potent as the quinolines with inhibitory potencies of 0.5 to 10  $\mu$ M. Based on the high level of inhibitory potency displayed by these compounds, a number of derivatives were prepared and tested to determine the structural features required for optimal inhibitory potency and enzyme binding. A number of these compounds are also being tested in galactosemic rats to determine their ability to prevent aldose reductase-mediated diabetic pathologies.

PSYCHOLOGICAL RAMIFICATIONS OF GUILLIAN-BARRE. Frances A. Breslin, Psychology Training Consortium, Univ. of Ala. at Birmingham, University Station, Birmingham, AL 35294, and Department of Psychology, Univ. of Ala., University, AL 35486.

Guillian-Barre is an autoimmune disease which involves the demyelination of peripheral nerves. Although stress, anger, and depression have been identified as the psychological correlates of the progressive, plateau, and recovery phases of the disease, patients in Birmingham underwent a different sequence. Because Guillian-Barre often begins insidiously as peripheral weakness in the legs or as ophthalmoparesis, many patients seeking care are deemed crocks by their family physicians or emergency room staff. This engenders anger and frustration in the patients as the disease quickly progresses. Acute stress occurs during the phase of relatively complete paralysis which often requires life-sustaining ventilation. Initially, the recovery phase is marked by optimism as the patients anticipate a relatively complete recovery. At the slightest setback or mild illness, this optimism fades and mild to severe depression or anxiety may occur. The length and severity of depression are determined by the patient's psychological strength.



THE TOXINS OF PERTUSSIS VACCINE: BIOLOGICAL IMPLICATIONS. Alvin L. Winters, Dept. of Microbiology, and Robert E. Pieroni, Dept. of Internal Medicine, Univ. of Ala., Tuscaloosa, AL 35487.

Paroxysmal whooping cough following *Bordetella pertussis* infection is complicated relatively frequently by secondary bronchopneumonias, neurological sequelae, and death. Control of whooping cough in the United States has been achieved through distribution of a whole cell vaccine to the pediatric population; however, deleterious side effects following vaccination have given impetus for the development of an acellular vaccine. A consensus about the components crucial for producing an immune response and resistance has not been reached and the role of these same components in the production of side effects has not been established. An acellular vaccine developed and distributed in Japan consists primarily of formalin-treated filamentous hemagglutinin and pertussis toxin (protective immunogen). Filamentous hemagglutinin is involved in adherence of the cell to tracheal ciliated epithelium. As postulated by Levine and Pieroni (Experientia 22:1-4, 1966), the protective immunogen has pleiotropic effects (histamine sensitizing factor, leukocytosis promoting factor, islet-activating factor, and ADP-ribosylating activity). The efficacy and side effects of the Japanese acellular vaccine are being evaluated currently; however, the acellular vaccine has diminished amounts of lipopolysaccharide (endotoxin). Similar to pertussis toxin, lipopolysaccharide has notable immunomodulatory activity. The mechanism of lipopolysaccharide induced immunomodulation (leukocytosis) appears to differ from that of pertussis toxin. Current opinions concerning vaccine reactogenicity will be discussed. This work was supported in part by Office of Naval Research Contract N00014-83-K-0597.

MODELLING OF DERMAL ABSORPTION. Angela M. Zwissler and Thomas Pierce, University of North Alabama Occupational and Environmental Health Laboratory, Florence, AL 35632.

Dermal absorption data represent critical elements in the evaluation of exposure using biological means. Before biological monitoring can become useful, however, reference values must be made available for comparison. The Biological Exposure Indices (BEI) Committee of the American Conference of Governmental Industrial Hygienists (ACGIH) is responsible for the development of these values. Human dermal absorption data are useful in the development of BEI's but are limited. Computer models have been developed which include factors such as partition coefficients, molecular weights and solubilities in water. While these models are subject to limitations, they do provide first-order approximations of permeation rates. Our work involves the application of three such models to approximately fifty industrial chemicals.

## Abstracts

RESPIRATORY SYNCYTIAL VIRUS (RSV) INFECTION IN ADULTS: CURRENT CONSIDERATIONS. S.M. Shatila, C.J.P. Sullivan, and R.E. Pieroni, Dept. of Internal Medicine, Univ. of Ala., Tuscaloosa, AL 35487.

RSV is a single-stranded RNA virus of the Paramyxoviridae family. Rapid diagnosis of an RSV infection is currently possible in a few hours through detection of RSV antigen by ELISA, RIA, or indirect immunofluorescence methods. Infections due to RSV may involve upper and/or lower respiratory tracts, and virtually all children have been infected by the age of 5 years. Immunity, however, is not permanent, and repeated infections are common to all age groups. The first infection, occurring during infancy or early childhood, is the most severe and more likely to cause bronchiolitis and pneumonia. Approximately 40-60% of pneumonias in children less than 3 years of age are caused by RSV. Reinfections in older children and adults are usually milder and involve the upper respiratory tract, and/or tracheobronchitis. However, elderly patients, and adults with underlying systemic diseases who present with atypical pneumonias and fail to improve on empiric antibiotic therapy, or who are seriously sick from such pulmonary infections, should have sputum sent for RSV antigen detection (results being available within several hours), and RSV culture. Therapy with ribavirin may be initiated pending above results. Although comprehensive studies on the efficacy of aerosolized ribavirin in adult populations with RSV infections are not available as of this date, this antiviral agent has proved extremely efficacious in such infections in childhood. However, the adult patient's immune status, the presence of other systemic disease, and the extent of virus infection all are likely to play a major role in the eventual outcome of treatment.

CORRELATION BETWEEN TWO METHODOLOGIES FOR TESTING RUBELLA IMMUNITY WITH RESULTS IN A FAMILY PRACTICE CENTER. W.R. Krause, J.D. Leeper, and R.E. Pieroni, College of Community Health Sciences, Univ. of Ala., Tuscaloosa, AL 35487.

Vaccination of children against rubella has resulted in both a considerable decline in the number of rubella cases and the exposure of unimmunized females to rubella. This is of considerable import in preventing the congenital rubella syndrome with all its tragic sequelae. Unfortunately, adolescents and young adults often lack protection against rubella. Recently, we found that over 15% of 300 females being screened prenatally at a family practice center were susceptible to rubella. We recommended that when patients of child-rearing age and undocumented immunization status visit their physicians, a new rapid Latex Agglutination (LA) test, Rubascan® be performed to determine rubella-susceptible patients who could be immediately vaccinated. Prior to instituting the program, however, we wished to compare the accuracy of the Rubascan® LA test with the conventional enzyme immunoassay (EIA) test. Our results, using 38 male and female patients of various ages, showed a 100% concordance between LA and EIA testing. The utility of rapid Rubascan® LA testing is therefore further re-enforced.

HOPE AND SOCIAL SUPPORT IN WOMEN WITH BREAST CANCER. Patricia P. Lillis, Dept. of Adult Nursing, Medical College of Georgia, Augusta, GA 30912

Cancer is one of the primary health problems confronting health care professionals. Support is needed by patients with cancer as they learn to live with their illness from the time of diagnosis through rehabilitation. Hope is recognized as an important ingredient in coping with life-threatening illnesses. The purpose of this correlational study was to describe the relationship between components of social support and level of hope in women with breast cancer. Norbeck Social Support Questionnaire and Purpose-in-Life Test were completed by each of 69 women ages 31-82 years who acknowledged their diagnosis of breast cancer and were receiving treatment in two health care settings. There was a statistically significant relationship between specified components of social support and level of hope in women with breast cancer when controlling for age, years of education, and length of time since diagnosis. Age was negatively correlated with level of hope as well as the quality and quantity of social support. Using stepwise multiple regression, total functional support and years of education were found to be the best predictors of level of hope in women with breast cancer. The findings indicated that improving social support could be an appropriate focus of nursing interventions to maintain a high level of hope. Nurses must be able to assess the person's level of hope and the influences of the person's environmental and support factors in order to foster the individual's capacity for goal achievement. The existence of or lack of hope affects the whole person and may be a critical factor in the prevention of illness and the maintenance of health.

SELF-REPORTING OF HEALTH PROBLEMS BY GROUPS OF ELDERLY. Mildred Hamner, Billie Ruth Henderson, Billie Rozell, University of Alabama School of Nursing, University of Alabama at Birmingham, University Station, Birmingham, AL 35294

The purpose of the study was to develop and determine the effectiveness of an audio/slide survey tool for self-reporting of health problems. Using group verbal and visual instructions, the groups were screened for visual, hearing, and dental problems of the elderly. Three nutrition centers were utilized and 57 subjects were screened. Advantages of the tool included the elimination of time-consuming individual interviews and provision of "tailoring" of resources needed for follow-up intervention. Problems in developing the tool were the inclusion of questions that could provide over-referral, and questions that could have been misinterpreted. After revision, the tool was evaluated, using the test retest technique, by 30 subjects. Additional evaluation is in progress. Such a tool would be cost effective in terms of time of health care workers in contrast to time spend on one-to-one interviewing. The elderly can follow group directions and report their health problems.

THE ANTIEMETIC EFFICACY OF ENCAPSULATED GINGER. James C. Pace, Dept. of Adult Health, Vanderbilt University School of Nursing, Nashville, TN, 37240.

Nausea and vomiting occur in 80-90% of patients who receive chemotherapy for the treatment of cancer. Nausea and vomiting pose problems for the patient's comfort, dietary intake, and activity level. The purpose of this study was to ascertain if selected nursing actions (the scheduled administration of Compazine injection and encapsulated ginger) relieved the chemotherapy-associated nausea and vomiting that are experienced by patients with leukemia. A double-blind, randomized pair, placebo controlled design was used. The experimental group consisted of 20 patients with leukemia who received scheduled doses of encapsulated ginger with Compazine injection; the control group consisted of 21 similar patients who received scheduled doses of a placebo with Compazine injection. All doses were given over a two day period. At the end of each treatment day, patients marked an instrument that measured relief of symptoms. Significant findings were that the experimental group reported less severity and duration of nausea. There were no significant differences in terms of severity, frequency, and duration of vomiting; comfort level; dietary intake; or activity level. Based on the findings, recommendations for future research include investigations to determine the therapeutic effects of ginger in different cancer patient populations, in different dosages, and in various patient care settings. Antiemetic protocols involving scheduled Compazine need to be evaluated in relationship to patient size, age, and level of debilitation. The therapeutic effects of placebos need continuing investigation.

PROPRANOLOL BINDING BY A PFC EMULSION. D.L. Parsons and H.F. Fan, School of Pharmacy, Auburn University, AL 36849.

Perfluorochemical (PFC) emulsions are being investigated as artificial oxygen carriers for treatment of refusal of blood transfusion and myocardial and cerebral ischemia. These agents have the potential to greatly alter the normal plasma transport of other drugs through interaction with plasma proteins or binding of drug. For this reason, the binding of a model cationic drug (propranolol) by a PFC emulsion was examined. The binding of 100 and 500 ng/ml propranolol by 100, 50, 75 and 25% v/v buffer dilutions of a PFC emulsion were determined by a dialysis exchange method and verified through a centrifugation method. Propranolol was extensively bound by the emulsion. The percent propranolol free in 100% v/v emulsion was 13.1% at both 100 and 500 ng/ml propranolol. This is very similar to the percent propranolol free in plasma. Buffer dilution of the PFC emulsion resulted in an increase in the percent propranolol free. At 25% v/v emulsion the percent free was 35.6% and 34.1% at 100 and 500 ng/ml propranolol, respectively. Propranolol did not partition from buffer into the purified perfluorochemicals. This indicated that propranolol bound by the emulsion was only associated with the droplet emulsifiers. This study has been supported by a Grant from the American Heart Association, Alabama Affiliate, Inc. The PFC stem emulsion (Fluosol DA®, 20%) was a gift from the Alpha Therapeutic Corp.

REACTIVE-ADAPTATION PROCESS: AN INTEGRATED THEORY OF NURSING BEHAVIORS. Virginia Pennington, School of Nursing, UAB, Birmingham, AL 35294.

The image of nursing advanced by the profession encompasses the characteristics of autonomy, assertiveness, decisiveness, risk-taking and role-breaking. The purpose of this study was to identify and compare the professional self-image of a group of female registered nurses with this image.

Using grounded theory methodology, research strategies used included participant observations, interviews, and administration of the Bem Sex-Role Inventory and the Tennessee Self Concept Scale to a sample of 15 female registered nurses. The data collected were sorted, coded, categorized, clustered, and conceptualized into a framework.

The Reactive-Adaptation Process was generated as an integrated theory used by nurses to fulfill their perceived role expectations within an ambiguous Health Care System. In this Process the responses of acting and reacting are adaptive behaviors which lead to goal attainment of making a difference or staying afloat.

It was concluded that: (1) the perceived role expectations of staff nurses serve as the stimulus for nursing behaviors; (2) staff nurses' role expectations are congruent with those advanced by the profession; and (3) the staff nurses' perceived role expectations of the System mean responsibility without authority.

Purposeful teaching of adaptation behaviors for staff nurses and nursing students in lieu of emphasis on assertiveness training is implied from the findings. Study of male staff nurses is recommended to determine the degree to which males may be capable of adaptation.

SIZE AND AMOUNT OF CELL DEATH IN RELATION TO SPONTANEOUS AND RETINOIC ACID-INDUCED POLYDACTYLY. S. Bynum and C. P. Dagg, University of Alabama at Birmingham, Birmingham, AL 35294

A partially inbred strain of ICR mice normally shows a low frequency of forepaw polydactylism which is increased after administration of retinoic acid to pregnant females on day 10 of gestation (Cusic '84). This defect in both untreated and treated fetuses was examined at the time when the extra digit first becomes visible as a bulge on the postaxial surface of the forepaw on day 14 of development. The bulge was apparent in nearly 60% of the untreated group and in 100% of the retinoic acid-treated group. Measurement of the area of the bulge showed that its size in the treated group was significantly greater than in the untreated group. The supravital stain, Nile Blue sulfate, was used to determine the extent and distribution of live and dead cells in the developing digit. Approximately 90% of the controls and about 50% of the treated fetuses had dead cells which nearly or completely filled the bulge. In the remaining controls and treated embryos, the amount of cell death in the bulge was variable but decreased relative to the bulge size. It was concluded that decreased amounts of cell death in combination with increased bulge size increased the frequency of polydactyly in the RA-treated embryos.

## Abstracts

PROLONGED FEVER, RENAL INSUFFICIENCY, AND HYPERCALCEMIA IN A FEMALE. P.L. Lovely, D.S. Smith, G.V. Merijanian, W.W. Winternitz, T.R. Lumpkin, G.D. Heggie, R.E. Pieroni, College of Community Health Sciences, Univ. of Ala., Tuscaloosa, AL 35487.

Elevated serum calcium levels can develop secondary to a wide variety of disorders, and, untreated, can result in profound morbidity, and even mortality. A common and feared cause of severe hypercalcemia is malignancy. Hyperparathyroidism, a frequent cause, is often amenable to surgery. Drugs such as thiazides, excess vitamins A or D, and certain antacids can also cause hypercalcemia. Of the many other causes, granulomatous disorders such as tuberculosis, sarcoidosis, and fungal infections should be included in the differential diagnosis. Recently, a 41 year-old female presented with a five month history of malaise, fever, occasional chills and sweats, and a 7 pound weight loss. About three months prior to hospital admission she had developed severe generalized itching. Her dermatologist, during routine chemical screening, found her serum calcium level to be considerably elevated (14 mg/dl). Renal insufficiency was also detected. In the hospital she continued to display a flu-like illness with lethargy and fever. A serum parathyroid hormone level was high-normal. After initial treatment of her hypercalcemia, numerous lab tests and x-rays were performed. A 2 cm lymph node was palpated in her left axilla. After considerable discussion concerning the etiology of her hypercalcemia, the lymph node was biopsied and revealed non-caseating granulomas consistent with sarcoidosis. Prednisone therapy resulted in immediate improvement in the clinical and laboratory manifestations of her condition, and she continues to improve.

A SUBACUTE TOXICITY STUDY OF  $\beta$ -SITOSTEROL IN THE MALE RAT. Ronald N. Hunsinger, Carrol Word, and W.D. Turner, Dept. of Biology and the School of Pharmacy, Samford University, Birmingham, AL 35229.

$\beta$ -Sitosterol is a phytosterol commonly found in wheat germ, corn, cottonseed, and soy beans. Typically, other closely related compounds, such as campesterol, stigmasterol and stigmasterol, also co-exist with  $\beta$ -sitosterol. Since it is very likely that these sterols are consumed on a regular basis by both humans and animals, and since very little data exist regarding their toxicity, the present study was undertaken. A mixture of plant sterols, consisting primarily of  $\beta$ -sitosterol, was administered to male Sprague-Dawley rats for 14 days (po, 2.5 or 25 mg/kg daily). At the end of the study, no significant differences between the control and treated groups existed for the following parameters: body weight; testicle-, seminal vesicle-, prostate-, adrenal-, kidney-, thymus-, heart-, liver-, and brain-organ-to-body weight ratios; total plasma protein; plasma calcium; plasma glucose; and BUN. However, minor elevations of plasma CPK and significant increases in plasma GOT were noted in the treated groups.

## Abstracts

### PATIENT INCIDENT PROFILES IN HOSPITAL RISK MANAGEMENT.

Walter J. Jones and James A. Johnson, Institute of Governmental Service and Research, Memphis State University, Memphis, TN 38152

Risks, especially those involving health, safety, and the environment are receiving increasing attention from institutional decision-makers in health care settings. Unfortunately, risk reduction policies have been enacted in response to complaints or lawsuits and have been rather haphazard in their development. There is a serious deficiency in the technical underpinnings of risk policies due to the tendency of scholars and decision-makers to slight the need for understanding institutional factors in controlling risks.

Our study, based on 969 patient incident reports from a large metropolitan hospital in the Southeast, sought to apply social science methods to the following objectives: 1) To describe the general pattern of patient incident occurrences; 2) To analyze the relationships between these occurrences and selected patient demographic and treatment variables; and 3) To explore the possibilities for development of predictive models for both regular and medication patient incidents. A control group of 189 non-incident patients at the hospital during the same period was used and all data was analyzed using the Statistical Package for the Social Sciences. The analysis revealed that patient incidents are significantly related to the variables of patient age, race, sex, diagnosis, and medication level. With further refinements, it is expected that such relationships can be used to construct predictive models for the management of risks in hospitals. This would help to reduce hospital costs and serve to enhance the patient care environment of these institutions.

THE MANY FACES OF PULMONARY EMBOLISM. Barry A. Ripps and Robert E. Pieroni, Dept. of Internal Medicine, Univ. of Ala., Tuscaloosa, AL 35487.

Pulmonary embolism is a common and potentially lethal complication in hospitalized patients. A conservative estimate of its incidence is 650,000 cases per year, with a relatively high mortality. In the undiagnosed group the mortality rate increases five- to six-fold. Based on post-mortem studies, pulmonary embolism has been listed as the third most common cause of death in the United States. It is, therefore, imperative to make the correct diagnosis early. Since the clinical presentation may be variable, an appropriate index of suspicion is required, as is proper identification of those patients belonging to high risk groups. We shall briefly discuss some of the ways to categorize those patients at risk for pulmonary embolism, and how to recognize the constellation of signs and symptoms associated with this disorder. Differential diagnoses will be discussed, as will a brief case presentation which demonstrates the need for perseverance in making the diagnosis in difficult or atypical cases.

AN UNUSUAL CASE OF MEASLES. R.C. Snyder, S.E. Gaskins, and R.E. Pieroni, Depts. of Family Medicine and Internal Medicine, Univ. of Ala., Tuscaloosa, AL 35487.

A 29 year-old physician was evaluated for a two-day history of myalgias and fever. Past medical history was insignificant with only incidental exposure to infectious diseases. Redness of his forehead and tonsils developed. A rapid strep test was negative, and a tentative diagnosis of viral syndrome was made. During the next two days he became increasingly ill with fevers of 104°F, chills, myalgias, and headache. The rash spread to his trunk, palms and soles. Nausea and coughing developed, and he was hospitalized. He developed conjunctivitis, papular eruptive lesions on his buccal mucosa, and right upper quadrant tenderness. Pending lab results, he was treated empirically for Rocky Mountain Spotted Fever. Over the next 4-5 days he remained weak and lost a total of 15 pounds. Multiple lab values were negative except rubeola titer, which increased from 1:4 during the acute phase to 1:32 during convalescence. The patient developed slow resolution of his rash without scarring. Photophobia and blurred vision persisted for five days. This case illustrates many of the classic features of rubeola ("red measles"). Numerous complications have been described including potentially lethal ones. It is important to underscore that rubeola is not just a childhood disease. Unfortunately, many adults, including this patient, have not been properly immunized. When the patient's sister had acquired the rubeola, he had received gamma globulin which resulted in lack of immunity. This case illustrates the need for continued surveillance of the immune status of our young adult population and to maintain optimal antibody levels.

VITILIGO AS A CLUE TO ENDOCRINE DISORDERS. R.E. Pieroni, College of Community Health Sciences, and G.D. deRocher, College of Arts and Sciences, Univ. of Ala., Tuscaloosa, AL 35487.

Vitiligo is an acquired abnormality which can result in the disappearance of pigment from the skin. It usually begins in multiple areas of the body and spreads peripherally. The cause of vitiligo is felt to result, at least in some cases, from autoimmunity. Several other disorders, especially those affecting endocrine glands, which may have an autoimmune basis have also been found in patients with vitiligo. Although occasionally endocrine hyperactivity may develop (e.g. hyperthyroidism), usually the converse is true and the condition known as pluriglandular deficiency syndrome may develop. The presence of vitiligo, therefore, can be a valuable clue to the possible presence of other disorders, as the cases presently described will attest. Therefore, medical evaluation of all patients with vitiligo is essential and can often lead to important and potentially life-saving diagnoses.



## Abstracts

CONTROVERSIES IN MANAGEMENT OF SUBARACHNOID HEMORRHAGE. R.E. Pieroni, E. Jones, and R. Russell, College of Community Health Sciences, Univ. of Ala., Tuscaloosa, AL 35487.

Considerable controversy remains concerning blood pressure (BP) management of patients with strokes, including those secondary to subarachnoid hemorrhage (SAH). Normally, the phenomenon of "cerebral autoregulation" can maintain optimal blood flow despite minor alterations in systemic BP. Drastic BP lowering in stroke patients can result in clinical deterioration and even death. In view of the above, some physicians recommend virtual "therapeutic nihilism" in treating BP of stroke victims. Others feel it is wise to treat elevated BP's in such patients, but opinions vary widely on what BP is indeed "optimal." To complicate matters, in stroke patients both alterations of cerebral autoregulation, and spontaneous BP fluctuations have been demonstrated. Even when antihypertensive treatment is contemplated, the appropriateness of specific medications has been debated. Mayo Clinic workers, for example, have recommended that patients with SAH receive positive inotropic agents to decrease the occurrence of potentially lethal cerebral vasospasm. Conversely, European workers advocate negative inotropic agents, e.g. propranolol, in such patients to diminish neurological deficits and enhance longevity. Calcium channel blockers such as nimodipine have been reported to decrease the incidence of symptomatic vasospasm as well as rebleeding in SAH patients. We shall discuss the controversial issues surrounding treatment of patients with stroke, especially secondary to SAH, and include our recommendations in view of the current state of knowledge.

LLOYD NOLAND: AN ALABAMA MEDICAL INNOVATOR. Paul J. Breslin and Robert E. Pieroni, College of Community Health Sciences, University of Alabama, Tuscaloosa, Alabama 35487.

Dr. Lloyd Noland came to the Birmingham area in 1913 to become superintendent of the Tennessee Coal, Iron and Railroad Company's health department. Noland had just left the Panama Canal Company's medical detachment where he had spent nine years as the famed Dr. William Crawford Gorgas' executive officer. The medical situation in Birmingham was every bit as grim as it had been in Panama. If the Birmingham area were ever to become heavily industrialized, something had to be done to improve health conditions. Through patience, hard work and an inspired public health policy, Dr. Noland was able to improve greatly the well-being of all the citizens of Jefferson County. Many of Dr. Noland's policies were later utilized by the U.S. Public Health Service.

## ENGINEERING AND COMPUTER SCIENCE

OPTIMAL ORIENTATION OF SOLAR PANELS IN SOUTH-EASTERN UNITED STATES.  
Gladius Lewis, Department of Mechanical Engineering, Memphis State University, Memphis, TN 38152.

Fixed flat plate fluid solar or photovoltaic collectors, which form the most important part of a solar system, need to have their orientation (with respect to the ground) optimized for the particular geographic location of the system, that is the latitude of the location. Generally, rules of thumb or empirical relations have been used to specify their optimal tilt. The effect is to either under - or over - size the systems, with the attendant decrease in performance or increase in cost.

A solution to this problem is to compute this optimal tilt,  $\phi$ , as a function of the latitude of location,  $\beta$  (with the aid of derived equations). This is the approach taken in the present work in which this optimal tilt has been obtained, using two different methods, for a total of 26 locations distributed over the 9 south-eastern states of the United States (Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina and Tennessee).

It is shown that, for example, for Alabama

$$\phi = - 4.84 + 1.39 \beta$$

and for the 9 states

$$\phi = - 4.27 + 1.37 \beta$$

The usefulness of these results is that a catalog of regression equations linking  $\phi$  and  $\beta$  have been generated which may be used as first-order tool in the design of solar systems in south-eastern U.S.

THE USE OF THE DELPHI TECHNIQUE TO CAPTURE ENGINEERING EXPERTISE.  
Terry C. Glover, Dept. of Civil Engineering, Univ. of South Alabama, Mobile, AL 36688.

The intent of the original research for the State of Alabama Highway Dept. was to define the relationship between existing asphaltic pavement distress and the opinions of experienced highway maintenance engineers. These personnel would include employees whose daily work called for judgments on roadway maintenance throughout the state's highway system. In order to capture this expertise, a method called the Delphi Technique was incorporated which allowed calibration of a linear rating scale to the various degrees of roadway maintenance required (as judged by the engineers). The scope of this paper is to present the Delphi Technique background and show how it was successful in accomplishing the desired task.

**PRO2: A User-friendly Environment for Building Expert Systems.**

S. Srinivasan, Pradip Dey., Dept. of Computer and Information Sciences., University of Alabama at Birmingham., AL 35294.

**Abstract**

An issue that is often overlooked while building expert system tools is the issue of user interface design and development support. Owing to the considerable success of expert systems in both business and industry, there is a need for a good, user-friendly tool to operate in harmony with the existing software environment. The success of expert systems will depend on how effectively the tool can access, retrieve, analyse and store various sources of data and knowledge. These activities are increasingly becoming part and parcel of an expert system development environment. To acquire knowledge, to get additional inputs from the user if the system does not have enough information to make a decision, to provide alternatives to the user to select from possible decisions are some of the features that can be provided with a good user interface. The expert system tool should have development support to facilitate the creative and intellectual step from the conception of an idea to its description in a computer-understandable form. Peculiarities of tools, programming languages, and user interfaces often present a formidable problem to the user: the user has to spend more time translating an idea into a computer language than polishing the idea to improve it. The development support should try to relieve the user from as many details as possible and permit concentration on the idea. To achieve this the development environment should be user-friendly.

This paper proposes an architecture that will not only provide with a good user-friendly environment to build expert systems but also a more dependable and robust tool to develop expert systems. This architecture is being adopted in a rule-based production system called PRO2.

**Interactive Bilingual Text Translator-Text Editor.**

Surawut Suchinroj, Yung-Tsu Jow, and Jong-Won Heo, Dept. of Computer and Information Sciences, Univ. of Ala. in Birmingham, Al. 35205.

This project involves a construction of an interactive machine translation program which translates text from a host file, sentence by sentence, and allows users to edit the host and the target language file at the same time. An efficient translation is accomplished by means of the functional transformation method. The functional transformation method is the main concept of our translation model. The computation of the transformation is defined by the transformation language, an intermediary language which is based on typed lambda calculus. The implementation scheme for this model of translation is developed and implemented for the translation from English to Pinyin (a phonetic romanization of Chinese). It has been shown in our studies that such a method can be used effectively for the purpose of an interactive machine translation where efficiency is the main concern.

CODE OPTIMIZATION BY PARTIAL EVALUATION (CODE OPTIMIZATION). Shan-Jon Chao and Barrett R. Bryant, Dept. of Computer and Information Sciences Univ. of Ala. at B'ham, B'ham, AL 35294.

Partial evaluation of denotational semantics is known as a good mechanism for compiler generation and code optimization. For compiler generation, a denotational semantic approach is used for the formal specification of programming languages. A compiler can be systematically constructed from the formal semantics specification by applying the specification function to the source program. The object code derived is a set of denotations which can be further optimized by partial evaluation. Partial evaluation of denotational code is sometimes called static semantic processing because it is performing those evaluation steps which are not dependent on execution-time values. This paper describes how to embed the Denotational Data Flow analysis into the partial evaluation processing for denotational code optimization. The denotational semantics of an imperative programming language contains the store algebra which is mainly used for the purpose of implementation of the programming language and also the side effects of the semantics of that language. The main idea of Denotational Data Flow analysis approach is to make the store algebra compile-time values. With this, an imperative language can be semantically data flow analyzed. The "side effect" semantics because of the store will be completely removed. An imperative program will be transformed into a functionally equivalent data flow program. A data flow program has two advantages over an imperative program. First, it is more efficient since it has been optimized. Second, it makes the implicit parallelism inside the program more easily detected when executed in a parallel environment. This feature will provide the possibilities of implementing imperative languages which are normally sequential on parallel computers. We may consider the following idea as our next goal. The code derived from the semantic definitions of a program are denotational ones and supposed to be executed on a denotational machine. For an imperative language, generating register code which can be executed on a von Neumann machine is preferred. The denotational approach for semantic definitions not only defines semantics but also provides information on implementation for imperative languages. The code generated from the denotational semantics definitions will be optimized by Denotational Data Flow analysis first, then translated into general register code. This is our future research.

[NEURAL NET] MEMORIZATION OF SHORT SEQUENCES IN NEURAL NETWORKS. Peter W. Thurston and Kevin D. Reilly (Research Advisor), Dept. of Computer Science, Univ. of Alabama at Birmingham, AL 35294. (also on leave from Univ. of Kent at Canterbury, Canterbury, Kent, UK)

Neural Networks have been studied for their utility in Artificial Intelligence as well as to gain clues as to various functions of the brain. Such networks are interesting because of the way the processing is distributed over a great many cells resembling those found in the nervous system called neurons. One particular property they possess is the networks resilience to damage, cell death and noisy and incomplete input data. A very fruitful area of research has been that of memory. Concepts are encoded as patterns and are stored so that pairs of concepts are associated enabling one to be recalled by the presentation of the other member. In this paper I explore some possibilities whereby a network will include an element of time. This is crucial if they are to take on complex tasks and become in a sense, general purpose *programmable* machines, combining the knowledge we have gained with conventional computers with the inherent advantages of neural networks.

A QUESTION-ANSWERING MODULE FOR A DECISION SUPPORT SYSTEM FOR STROKE. Ping-Yang Li, Department of Computer and Information Sciences, University of Alabama at Birmingham, Birmingham, AL 35294.

A question-answering system for assisting physicians in the management of stroke is being developed using data from the stroke database of Michael Reese Hospital at Chicago. We were motivated to develop this component by evidence that physicians are much more willing to use systems that provide interactively responses. These responses will include information entered into the system by the user, plus inferences which the system has made from that information.

Our system processes a query roughly in three stages: query analysis, information retrieval, and response generation. In the stage of query analysis, our objective is normally not just the parsing of a query, but figuring out what the query means. This task is complicated by the many different constructions which can be used to express a particular idea. To simplify this task, we are using paraphrastic transformations to reduce this variety, that is, taking a group of queries related by paraphrastic transformations and mapping them all into a single query format. In this way the subsequent stages of analysis have to handle a smaller range of constructions. To implement this methodology, the query analysis, which is performed by Sager's Linguistic String Parser, will first check the grammatical properties of an input query and construct a parse tree. This parse tree is then regularized and mapped into a conceptual structure, called a query format, by applying paraphrastic transformations. On the basis of the structure, the second stage produces a pool of relevant knowledge. The type of information available in this pool is used to select a single information format from the set of possible information formats. The answer is constructed by "filling" the format. When the information format has been filled, the Linguistic String Parser then applies reverse-transformations to generate the message.

Clearly we have only begun to explore the possibilities of reverse transformations. Sager's Restriction Language makes it easy to write and experiment with other transformations. As part of our long term research into techniques for natural language processing, we have already developed a question-answering system which can both process queries and generate responses from data in the Michael Reese Stroke Database.

Linear System Solver - George T. Crocker  
Department of Mathematics, Engineering and Computer Science  
Samford University, Birmingham, Alabama 35229

D. J. Evans has introduced linear system solvers which require a different factorization than the usual methods. The X.Q.I.F. method transforms the matrix  $A$  of the system  $AX=B$  into a matrix with nonzero elements only on the diagonals. The advantages and disadvantages of this transformation will be discussed and an algorithm for it given. The algorithm uses repeated solutions of  $2 \times 2$  linear systems to achieve an inherent parallelism. Examples will be presented to illustrate the technique.

## Abstracts

A Probabilistic Model of Diffusion in Tissue. C.M. Topakoglu,  
Dept. of Mechanical Engineering, Univ. of South Ala., Mobile, AL 36688

A mathematical model describing the diffusion and consumption of oxygen in the tissue of the brain was developed. The stochastic random-walk technique was applied to the system which consisted of a block of tissue supplied by an adjoining capillary which represented the source. The method of system description treated the oxygen molecules individually and tracked their position which changed according to a specified probability distribution. This method of solution incorporated a uniformly generated random number which was weighted by the normal distribution curve to determine the random walk, or movement of any particular molecule. The distribution curve is a function of the diffusivity of the species in the surrounding environment and time. The method allows precise tracking of individual molecules as they proceed through the tissue as well as through metabolic reactions. Oxygen is presented as the primary component of study although other metabolites have also been modeled, as well as their interactions with each other. The consumption and/or production of these components can be made dependent on probability values assigned to each metabolic reaction into which they enter. By specifying appropriate boundary conditions the diffusion of a particular species can be simulated. The model was found to be sensitive to changes in the metabolic scheme parameters and to oxygen levels in the capillary. A limitation of the method was the constraint put on by the large amount of computer time necessary for a solution. This model is intended to serve as a methodology for the simulation and analysis of biochemical processes at the cellular level.

COMPUTER CHOICE FOR UNDERGRADUATE SCIENCE AND ENGINEERING. James H. Lane, Dept. of Civil Engineering, Univ. of S. Ala., Mobile, AL 36688

A comparison is made between microcomputer systems for use in conjunction with undergraduate science and engineering curricula. The comparison includes systems (including monitor and printer) ranging in cost from \$400 to over \$2000. Comparison is made on the basis of initial cost, maintenance cost, software suitability and cost, programming languages, and overall effect on the educational program. The conclusion is reached that, although the expensive computers are more versatile, the less expensive ones will be most effective in terms of overall benefits.

CLUSTERING ANALYSIS ON A MICHAEL REESE STROKE DATABASE. Danny C. Deng and Ping-Yang Li, Dept. of Computer and Information Sciences, Univ. of Ala. at B'ham, University, AL 35294.

An unique characteristic which distinguishes an expert from a novice is the ability to reason by analogy. Reasoning by analogy involves procedures which are based on similarity measurements between medical patterns. Such similarity measures are also the nucleus of similarity-based learning by which a given knowledge base may be refined to include exceptions to the standard rules.

In this project, we propose a method which is based on similarity measurement. Similarity measurement, technically speaking, is also known as clustering analysis in the computer application areas. Clustering analysis is an existing methodology primarily implemented in information retrieval field. To simplify file access and manipulation of large masses of data, clustering is thus used to group similar or related items into common classes. The idea is that items, in a clustered file, are grouped into classes in such a way that all items entered into a common class exhibit certain similarities. When a clustered file is used for retrieval, it is no longer necessary to examine every item in the file, instead the search can be restricted to certain classes of items that appear to be "close" to the request.

The goal of this project is to utilize an existing set patients with proven diagnosis in inferring according to the principle that patients that look alike are likely to be alike. Consequently, the same medication can be applied to a particular patient who has similar findings. The anticipated significance of this study will lead to the development of a new method suitable for use in computer-supported decision aids in medicine using similarity (distance) measurement. Furthermore, the system will be capable of acting as a teaching aid that simulates a stroke patient and provides a direct comparison.

The data for this study will be derived from the Michael Reese Stroke Database which contains information about 566 of cases of stroke and transient ischemic attacks (TIAs) collected over the last five years.

SOLVOLYSIS OF ALABAMA COALS. Jagdish C. Dhawan, Dept. of Chemical Engineering, Univ. of South Alabama, Mobile, AL 36688.

Hydrogen donor and acceptor abilities of high-boiling polynuclear aromatics such as petroleum pitches have led to thermal degradation and stabilization of coal fragments in the absence of external hydrogen source. This kind of liquefaction approach was applied to several Alabama coals which were solubilized near ambient pressure at 400°C temperature using pitch and pyrene as solvents. Results show that the extent of solubilization depends strongly upon the nature of coals as well as the solvent under these conditions. For some Alabama coals, about 80% liquefaction yield is attained in petroleum pitch. This work is supported by the Alabama Research Institute.

## Abstracts

### ANTHROPOLOGY

A PRELIMINARY REPORT ON THE CORRELATION BETWEEN MODERN ELEPHANT BEHAVIOR PATTERNS AND PROPOSED SIMILAR MAMMOTH BEHAVIOR: A MODEL FOR PALAEOINDIAN SUBSISTANCE STRATEGY. Patricia A. Kirkland, Dept. of Anthropology, University of Alabama, University, AL 35486.

Upon entry into the Western Hemisphere during the late Peistocene, *Homo sapiens* represented by the archaeological culture designated Clovis developed a prediliction for the systematic procurement of mammoths (Frison 1986; Hester 1971). Being range-conscious and small-group oriented mammals, the movements of groups composed of females and young would be more easily predictable as opposed to more solitary males, thereby providing a more productive food resource. It has been previously postulated that mammoths possess similar behavior patterns to their modern counterparts (Frison 1978, 1986), then such a preference is explainable. PalaeoIndian hunters would have recognized and made use of these patterns towards the strategy and tactics of procurement. Given this assumption, we would expect the following attributes to apply to mammoth kill sites; a high incidence of female and young kills in fixed context, a low frequency of intermediate age kills, and a higher frequency of females and young in multiple kill sites in fixed context.

ANALOGY AND EXPERIMENT: THE ANTHROPOLOGICAL POTENTIAL FOR LIVING HISTORY AT FORT TOULOUSE. Alan F. Kirkland, Dept. of Anthropology, University of Alabama, University, AL 35486.

Historic site archaeology plays an important role in the scope of southeastern research. The correlation between archaeological evidence and historical records allows us a more detailed view of the past. Such research is vital to a greater understanding of the convergence of European and Native American cultures during the late seventeenth on through the eighteenth centuries in the southeastern United States. The use of a very general model, such as the Fort Toulouse Living History Program, would be useful for interpretive hypotheses about Franco-aboriginal lifeways. The model presented within this paper treats the Living History Program as an example of experimental archaeology, which undergoes constant modification with the aquisition of new evidence through archival, experimental, and archaeological research.



## Abstracts

DENTAL EVIDENCE OF CORDAGE MANUFACTURE BY WOODLAND PERIOD CHILDREN. Kenneth R. Turner, Dept. of Anthropology, Univ. of Ala., Tuscaloosa, AL 35487.

A form of dental attrition found on incisors, and occasionally on canines or premolars, has been recognized to be a consequence of the use of those teeth in the processing of plant fibers toward the manufacture of cords. All reports of this attrition pattern have concerned adult dentitions. The skull of a child approximately six years old, recovered through archaeological fieldwork in North Alabama, exhibits incisors with this distinctive attrition pattern. The child, who lived approximately 1,300 years ago, apparently not only manufactured cordage from plant fibers, but had done so for some time. The implication of this occurrence is that very young children played a noteworthy role in the economics of at least some prehistoric Native American societies, a role which has been ignored in cultural reconstructions. The biological conditions and consequences of this phenomenon are explored.

MORTUARY PATTERNS AND PRACTICES. Michael A. DeLuca, Laboratory for Human Osteology, Dept. of Anthropology, Univ. of Ala., University, AL 35486.

This paper presents the preliminary research of an ongoing study of mortuary patterning. Previous researchers have focused on prehistoric social systems. These studies involve many assumptions based on weak ethnographic analogies and as a result their conclusions are questionable. Most students of mortuary practices feel they are more capable of studying cultural processes than ethnologists because of the nature of the archaeological record. However, no researchers to date have made an attempt to analyze culture change. It is my belief that valuable information concerning cultural processes can be gained from the analysis of mortuary practices and that a method to elicit this information can be developed.

TERMINAL WOODLAND SCENARIOS in CENTRAL ALABAMA. David W. Chase, Auburn University at Montgomery, Montgomery Alabama, 36117.

This paper expands upon an earlier presentation describing the Hope Hull Phase, a major cultural entity during the late Woodland period in Central Alabama. The theme illustrates intercultural relationships between the Hope Hull people and their nearest neighbor archeologically defined as the Autauga Phase which group may have been a major factor in compelling the abandonment of the Hope Hull people from their Tallapoosa River homeland.

MINUTES

ALABAMA ACADEMY OF SCIENCE  
ANNUAL BUSINESS MEETING  
University of North Alabama  
Florence, Alabama  
March 27, 1987

1. Dr. Phil Beasley, President of AAS, called the meeting to order at 5:45 P.M.

2. The President asked for the "Report of the Counselor to the AJAS." Dr. Eugene Omasta sent the following report to the Secretary after the meeting:

AJAS Final Report for the Annual Meeting 1987

The 1987 annual meeting was hosted by the University of North Alabama at Florence and like all previous meetings, was shared with the Alabama Academy of Science.

The winners of the scientific paper competition were:

Physical Science	1st place	Diane Hunter*	Altamont
	2nd place	Christina Rodriguez	Auburn
Biology	1st place	Scott Brightwell	Sidney Lanier
	2nd place	Cecily Crowder	Bradshaw
Humanities	1st place	James Crowder	Bradshaw
	2nd place	Shelly Dunkin	Brewer
Engineering	1st place	Richard Hall	Athens
	2nd place	Jeff Whitaker	Altamont
Mathematics	1st place	John Katz	Sidney Lanier
	2nd place	Jerry Sasser	Escambia

\*Overall winner who will represent Alabama in the paper competition that is a part of the National JSHS Symposium at West Point, NY, on May 6-9, 1987. The other 1st place winners will accompany Diane Hunter on this expense paid trip.

Other awards were:

Expense paid trip to West Point and the Army Award (\$300 for supplies and a certificate) - Teacher-sponsor of the overall winner:

Robert S. Davis                      Altamont

AAAS - A subscription to a scientific magazine:

Tim Palmer                              Hillcrest

## Minutes

### Grant for a research project:

Sandra Padgett	Jackson Academy	\$167.12
Jaimena Robinson	Bradshaw	94.50
Chavigny Beasley	Athens	235.00
Tammy Coker	Escambia	41.50

### Outstanding Teacher (more than five years) - \$100 and a certificate:

Betty Bigham	Mary G. Montgomery
--------------	--------------------

### Outstanding Teacher (less than five years) - \$100 and a certificate:

Beth Sherrill	Hillcrest
---------------	-----------

### Outstanding Region - An engraved plaque:

Northwest Region	Counselor's - Linda Kanipe & Cynthia Tillery
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### Newly elected officers for 1987-88:

President	Champ Thomaskutty	Brewer
Vice-President	Richard Hall	Athens
Treasurer	Russell Brockwell	Bradshaw
Secretary	Chavigny Beasley	Athens

Many persons deserve special thanks for their efforts in support of the 1987 annual meeting, including: Faye Wells for her work as local arrangements person for AJAS in making plans and arrangements for the meeting rooms, motel rooms, tours, and other activities; David Currott for his work as the overall local arrangements person in planning and assisting AJAS at this meeting; Linday Kanipe and Cynthia Tillery as counselors of the host Northwest Region for arranging for the dance, arranging for gifts and materials for the students from local merchants, assisting with registration, and planning and assisting with the meeting; the state officers for their support and assistance - Anthony Merriweather (President), Jerry Sasser (Vice-president), Scott Henry (Treasurer), Shari Garber (Secretary); the judges of the paper competition for both judging and their concern for student scientific development - James W. Daniel, Chris Hammer, Richard A. Lane, George MacCrone, and Bobby C. Park from the U.S. Army Command Missile Command, Claude Breed, Ken McGill, Gerald G. McGlammer, and Jean Ray from the Tennessee Valley Authority, Terry Belvin, Tom Pebworth, and Mike Perez from the University of North Alabama, Harry Harvey, John Holland, and Charles E. Keys from Florence, John W. Lee, William Smith, and Edward H. Ward from Troy State University; and also the associate counselors for their continued dedicated service to AJAS - Betty Bigham and B.J. Bateman.

## Minutes

We appreciate the support of the Senior Academy in AJAS activities, especially the support of this year's president, Dr. Philip Beasley.

3. The President called for the "Report of the State Coordinator of Science Fairs." Ms. Elsie Spencer presented the following report:

1987 Alabama Regional Science Fairs Finalists are:

WEST REGIONAL - U. of A.-Tuscaloosa

Lisa Mancini, Tuscaloosa County High, Northport  
Tim Clements, Tuscaloosa County High, Northport

MOBILE REGIONAL - U. of South Al.-Mobile

Alicia Tremer, T. R. Miller High School, Brewton  
Ronda Gamache, Monroe County High, Monroeville

CENTRAL - UAB, Birmingham

Teresia Hook, Resource Learning Center, Birmingham  
Glenn Kinstler, Altamont School, Birmingham

EAST - Auburn University - Auburn

William Chen, Auburn High School, Auburn  
Cheryl Neuman, Auburn High School, Auburn

SOUTHEAST - Troy State University - Troy

Eric Olson, Opp High School, Opp  
Charles McBryde, Opp High School, Opp

NORTHEAST - Talladega College - Talladega

Howard Matthew O'Neal, Talladega High School, Talladega  
Linda Christine Wyckoff, Childersburg High, Childersburg

NORTH - Calhoun State Community - Decatur

Cham Thomascutty, Brewer High, Somerville  
Richard Hall, Athens High, Athens

4. Dr. Beasley then asked for the "Report of the Gorgas Scholarship Foundation." Dr. L. S. Hazlegrove reported the following:

The Gorgas Scholarship Foundation announced the finalist rankings in the 1987 Alabama Science Talent Search held at the meeting of the Alabama Academy of Science at The Univ. of North Alabama, Florence, AL.

The winner of the cash award of \$2,500 tuition grant was:

Mary Christine Braddock, Decatur High School, Decatur, AL.  
Teacher, Lenore T. Cooper.

Alternates were:

1st (and winner of a \$1,500 tuition grant):

Darryl Edward Granger, Randolph High School, Huntsville, AL.  
Teacher, Robert Kirchner.

# Minutes

2nd (and winner of a \$1,000 tuition grant):

Christie Diane McKendree, T. R. Miller High School, Brewton, AL.  
Teacher, Carrie Edge.

3rd Eric Christopher Olson, Opp High School, Opp, AL.  
Teacher, Barbara S. Reynolds.

4th Julie Allison Guthrie, Erwin High School, Birmingham, AL.  
Teacher, Sophia Clifford.

5th Elisabeth Leigh Gullett, Henry A. Bradshaw High School,  
Florence, AL. Teachers, Mary Nell Gonce and Rachel S. Minor.

6th Cecily Candace Crowder, Henry A. Bradshaw High School, Florence,  
AL. Teachers, Mary Nell Gonce and Rachel S. Minor.

7th James Victor Crowder, Henry A. Bradshaw High School, Florence,  
AL. Teachers, Mary Nell Gonce and Rachel S. Minor.

8th Keith Lynn Fields, Jr., T. R. Miller High School, Brewton, AL.  
Teacher, Carrie Edge.

9th Larry Ellis Nichols, Erwin High School, Birmingham, AL.  
Teacher, Sophia Clifford.

10th Jonathan Richard Powell, Henry A. Bradshaw High School, Florence,  
AL. Teachers, Mary Nell Gonce and Rachel S. Minor.

The judges consisted of department heads, deans, and professors  
from universities and leaders from industries in Alabama.

Dr. Leven S. Hazlegrove, Professor and Chairman, Department of  
Chemistry, Samford University, is Chairman of the Judges Committee.

Winners and alternates in the Gorgas Contests receive offers of  
tuition scholarship to colleges and universities in Alabama for the  
study of science. the Gorgas Foundation is named for General William  
Crawford Gorgas, the Albama physician who conquered yellow fever in the  
Panama Canal Zone and later became the Surgeon General of the U.S. Army.  
The purposes of the Foundation are to promote interest in science and to  
aid in the education of promising students.

5. Dr. Beasley called for the "Report of the Secretary." Dr. Ann  
Williams presented the following report:

Membership, March, 1986 . . . . .	858
Members dropped for non-payment of dues (Sept., 1986) . . . . .	-140
Members deceased . . . . .	- 2*
New members added . . . . .	+117
Members reinstated . . . . .	+ 41

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Total membership, March 25, 1987 . . . . .	874
Net difference from March, 1986 . . . . .	+16

# Minutes

## MEMBERSHIP BY SECTIONS

<u>Section</u>	<u>March, 1986</u>	<u>March, 1987</u>	<u>Change</u>
1	215	235	+20
2	73	84	+11
3	42	49	+7
4	33	34	+1
5	99	90	-9
6	70	68	-2
7	37	42	+5
8	33	33	0
9	153	152	-1
10	51	54	+3
11	27	28	+1
99	25	5	-20
			<hr/> +16

\*Robert L. Settine, Thomas St. Pierre  
173 memberships from 1986-87 are still unpaid and will be dropped in June.

6. The President asked for the "Report of the Place of Meeting Committee." Dr. Joe Thomas presented the following:

The Committee on Place of Meeting for the Alabama Academy of Science wishes to report that the following future meeting sites have been established and confirmed by the respective institutions and the Executive Committee of the Alabama Academy of Science.

- 1988 -- Auburn University
- 1989 --- Birmingham Southern College
- 1990 -- Mobile College
- 1991 -- Jacksonville State University
- 1992 -- The University of Alabama

To give proper distribution and movement throughout the State the Committee on Place of Meeting feels that the 1993 meeting could be held in the north part of the State such as in Huntsville or the areas from Montgomery south. The Committee stands ready to accept institutional invitations from these areas for the 1993 meeting.

It is felt that this Committee should not be negotiating for meeting sites beyond 1993.

7. The "Report of the Resolutions Committee" was next called for by Dr. Beasley. Dr. Steve Sax presented the following resolutions:

Expressions of appreciation were presented to Dr. Robert Guillot, President of UNA, Dr. David Currott, the Local Arrangements Committee (Drs. Joe Thomas, William Matthews, Michael Moclier, Faye Wells, Gary Green, Tom Pierce, Paul Kittle, Joseph Wallace, Ray Isbell, and Jack Moore), Mr. Jeffrey Deardorff, and Dr. David G. Haase for their contributions to the success of the 64th Annual Meeting of the Academy.

The Resolutions were approved unanimously by the membership.

## Minutes

Dr. Barker moved that the members stand for a moment of silence in respect for two deceased members of the Academy, Drs. Settine and St. Pierre. Such action was taken by the membership.

8. Dr. Beasley then asked for the "Report of the Research Committee." Dr. Garstka reported the following:

Evaluations were carried out by Section Chairs and others within each session. The new procedures of application for the Research Awards which involved only the submission of an abstract did not increase the number of students participating in the competition. However, the number of students applying for Grants was increased to 19. Dr. Garstka requested approval of the Academy for the Travel Grants, Research Awards, and Research Grants. Twelve students have applied for Travel Grants for a total of \$475 with a maximum award of \$50. Awards have been limited to those students who are competitors in the Research Competition. Student Research Awards were awarded in 6 Sections.

Biological Sciences: Holley Handley

Chemistry: Milton D. Mathis

Geology: David L. Violette

Forestry, Geography, Conservation, and Planning: Andrea P. Holland

Health Sciences: Virginia Pennington

Engineering and Computer Sciences: S. Srinivasan

The Committee recommends that a \$50 award and a certificate signifying their recognition be awarded to these students.

Nineteen proposals were submitted for Research Grants. The Committee evaluated them and the top ten were determined. Two proposals were awarded \$250 Grants: Fleming and Daniels; four proposals received \$200 Grants: Findlen, Bidanset, Russell, and Handley; and four proposals received \$100 Grants: Miculek, Peebles, Nesdill, and Chao. The total awards amounted to \$2475.

Dr. Moeller moved acceptance and Dr. Barker seconded. The proposal was approved unanimously.

9. Dr. Beasley asked for the "Report of the Nominating Committee." Dr. Ken Turner submitted the following list of nominees, all of whom were elected unanimously:

Second Vice President: Adriane Ludwick

Treasurer: Caroline Adams

Associate Counselor-JAS: B. J. Bateman

Trustees: R. A. Peacock

J. C. Thomas

Sam Barker

Stan Jones

## Minutes

### Section Officers:

#### Section I - Biological Sciences

1. Richard F. Modlin, Chair
2. Randy Brooks, Vice-Chair

#### Section II - Chemistry

1. Michael B. Moeller, Chair
2. Barry J. Corona, Vice-Chair

#### Section V - Math and Physics

1. Lou Destito, Chair
2. Jack Waite, Vice-Chair

#### Section VI - Industry and Economics

1. Philip Gregorowicz, Chair
2. Keith Absher, Vice-Chair

#### Section VIII - Social Sciences and Communications

1. Bill Osterhoff, Chair
2. Lawrence Hanks, Vice-Chair

#### Section IX - Health Sciences

1. Robert E. Pieroni, Chair
2. Ken Francis, Vice-Chair

#### Section X - Engineering and Computer Science

1. Susan T. Dean, Chair
2. Terry C. Glover, Vice-Chair

#### Section XI - Anthropology

1. Janice Gilliland, Chair
2. Elizabeth Sheldon, Vice-Chair

10. The President called for "New Business."

a. Dr. Karen Cagle moved for the Academy's approval for the Section Chair to initiate plans for a Symposium sponsored by Section VI on "Technology Transfer in Forestry and Wood Products."

The membership approved such action.

b. Dr. Moberly moved that the Academy adopt a project for the coming year. He proposed that we assemble a resource data-base listing of the academy membership including individual's research interests and possible contributions to industry and government in a loose leaf format. The motion requested that an Ad hoc committee be appointed to work toward a presentation at the Fall Meeting.

c. Dr. Frandsen questioned the Academy's silence on the Mobile Court decision on Secular Humanism and textbook selection. After some discussion, Dr. Bradley moved that the Science and Public Policy Committee address the issue.



## Minutes

The motion was passed unanimously.

11. Having no further business to conduct, the meeting was adjourned at 6:30 P. M.

## Notes

# Notes

## Notes

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DISTRIBUTION OF HIGH SCHOOL FOOTBALL  
INJURIES THROUGHOUT THE SEASON<sup>1</sup>

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INTRODUCTION

Football is one of the most popular sports in our country. Even at the high school level, a great deal of emphasis is placed on participation in football. High school football generally begins in August and continues through November, excluding post season playoff competition. Previous studies have investigated football injuries in an effort to ascertain probable causes and mechanisms of injuries (Allen, 1966; Albright et al., 1985; Blyth and Mueller, 1974; Cahill and Griffith, 1979; Culpepper and Niemann, 1983; Olson, 1979). However, comparison of results are often difficult due to the method of data collection, level of competition, and style of play. In addition, the availability and delivery of adequate health care is important for the treatment and rehabilitation of football injuries. Therefore, medical facilities and professional personnel need to be aware of potential injuries and the time which these injuries occur.

A description of football injuries with respect to the week of the season that an injury occurs has not been fully established. A more comprehensive understanding of this aspect of football injuries can be of great value to coaches and those involved with health care of student athletes. Therefore, as part of a research effort to develop an overall injury characteristic profile of high school football injuries, a study was conducted to describe football injuries and the week of the season that they occur.

METHODS

Varsity high school football injury data from the Kerner-Quarterback Sports Medicine Institute at the University of Alabama at Birmingham for a four year period were retrospectively examined. Approximately 3,000 patient visits are currently made each year at the Institute, with the majority of those being from high school athletes. The Institute

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<sup>1</sup>Manuscript received 24 April 1987; accepted 7 August 1987.

works closely with the surrounding schools in the delivery of health care for their athletic programs and assists the Department of Adolescent Medicine in performing over 1,500 preseason physical exams annually. Medical records are kept pertaining to the injuries of the players who are treated at the Institute. Injury data such as age, height, weight, sport/position, injury type, body area, schools, in addition to other information, is sorted in a computer and can be selectively retrieved.

A fundamental problem associated with the assessment and comparison of sports injuries is the manner in which the injury data are collected, recorded, and reported. Methods of data collection have ranged from questionnaires (Blyth, 1974) and interviews (Garrick and Requa, 1978) to medical records (Clark, 1964) and insurance forms (Allen, 1966). Although each method has its limitations, they all contribute to the understanding of the characteristics of football injuries. For the purpose of this study, an injury is defined as any traumatic change in a student athlete's medical condition that occurred during a game or practice during the regular football season.

The football season was divided into 14 weeks. The first three weeks included summer or preseason practice while the remaining 11 weeks incorporated the actual playing season. A typical season includes 10 games with one bye. The final regular season game is scheduled at the end of the fourteenth week and post season competition begins thereafter. However, post season play is not included because the number of injuries would decrease as the number of school decrease throughout the playoff games and could possibly bias the results.

The chi-square test, which measures the differences between actual and theoretical frequencies of a particular injury, was used for statistical analysis. Injury type, body area, and player position were examined with respect to the number of injuries and the week of the season that they occurred. The theoretical frequencies for injury type, body area, and player position were calculated from the distribution pattern of the total injuries instead of a straight line pattern of 116 injuries per week (1,623 divided by 14 weeks). A difference was considered significant if the chi-square was greater than or equal to that required to satisfy the 0.05 level of probability.

## RESULTS AND DISCUSSION

A total of 1,623 injuries were recorded during the four year period. Tables 1, 2, and 3 show the number of injuries that occurred throughout the season with respect to injury type, body area, and player position. These data are similar to previous studies (Blyth and Mueller, 1974; Olson, 1979). No attempt was made to normalize the number of injuries with respect to the number of players that play a particular position (Table 3). For example, there may be one quarterback, but there are more than one running back, lineman, and linebacker. However, the various styles of play among the schools make it difficult in determining the appropriate number for each player position. For example same schools use 3 linebackers and 2 running backs while others may use

## High School Football Injuries

4 linebackers and 3 running backs. Therefore, if any player said he was playing linebacker when he got hurt, then the position "linebacker" was used and is reflected in Table 3.

Table 1. Distribution of Injuries by Injury Type

Injury Type	Number	Percent
Contusion	423	26.1
Dislocation	33	2.0
Fracture	180	11.1
Sprain	515	31.7
Strain	204	12.6
Tear	56	3.5
Other	212	13.1
Total	1,623	100.1

Table 2. Distribution of Injuries by Body Area

Body Area	Number	Percent
Head/Neck	125	7.7
Shoulder	209	12.9
Elbow	55	3.4
Hand/Fingers	190	11.7
Chest/Ribs	59	3.6
Lower Back	68	4.2
Upper Leg	80	4.9
Knee	345	21.7
Lower Leg	63	3.9
Ankle	171	10.5
Feet/Toes	72	4.4
Other	186	11.5
Total	1,623	100.4

Table 3. Distribution of Injuries by Player Position

Player Position	Number	Percent
Quarterback	155	9.6
Running Back	328	20.2
Receiver	228	7.3
Tight End	89	5.5
Off. Lineman	384	23.7
Def. Back	141	8.7
Linebacker	140	8.6
Def. Lineman	155	9.5
Other	113	7.0
Total	1,623	100.1

Figure 1 shows the distribution pattern of the total injuries throughout the season. The distribution pattern is characterized by weekly fluctuations the first six weeks, a slump in the eighth week, followed by a gradual rise before a declining trend the final three weeks. The weekly fluctuations cannot be readily explained. However, many early injuries may occur to younger or nonregular players. Once the season is underway, these players may not be involved with games or practice as they were in the beginning. The decline the final two weeks may be due to the fact that the end of the season is near and players may not seek treatment since there are no future games for which to prepare.

The most common injury types were contusions, fractures, strains, and sprains. These four types account for over 80% of all injuries (Table 1). Figure 2 illustrates the distribution patterns of these injuries throughout the season. There are weekly fluctuations among these injury types. The frequency of strains were greatest during preseason and generally declined throughout the season. Contact injuries such as contusions and fractures were evenly distributed throughout the season once games began, and followed similar fluctuation patterns. There were fewer contact injuries during the first three weeks before the games began. Game 1 generally occurred at the end of week three. Thus, during the very first week of preseason and right before the first game, many practices are arranged so that heavy contact is limited, keeping contact injuries at a minimum. Although these descriptive patterns seem evident, chi-square analysis revealed no significant differences among any injury types. This is probably due to the fact that the theoretical frequencies are calculated from the distribution pattern of the total injuries instead of a straight line average of 116 injuries per week.

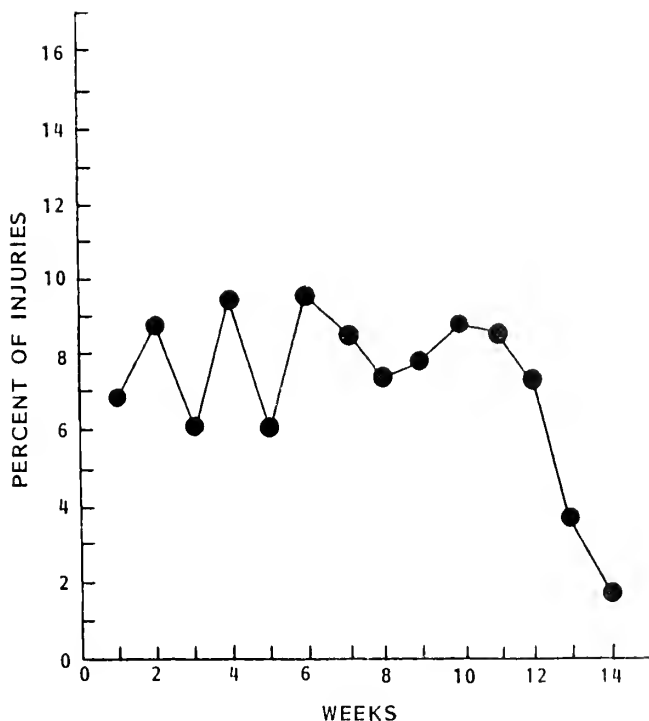


Figure 1. Distribution of injuries throughout the season.

Over half of all injuries occurred to the head/neck and shoulder, knee, and ankle (Table 2). Figure 3 shows the distribution patterns of injuries to these body areas. The number of head/neck and shoulder injuries were least during the preseason, possibly reflecting limited contact in practice during this time. The number of ankle injuries were greatest earlier in the season and declined throughout the remainder of the season. Injuries to the knee generally declined the first six weeks, but rose again and reached a peak at twelve weeks. However, this descriptive pattern demonstrated no significant differences in the week of the season in which they occurred, compared to the overall distribution pattern.

Almost half of all injuries occurred to quarterbacks, running backs, wide receivers, and defensive backs (Table 3). These data are similar to previous reports indicating that those players that handle the football are most likely to receive an injury (Blyth and Mueller, 1974; Garrick and Requa, 1978; Olson, 1979). Figure 5 shows the distribution patterns of injuries occurring to these positions. The number of injuries to quarterbacks was least earlier in the season and reached a

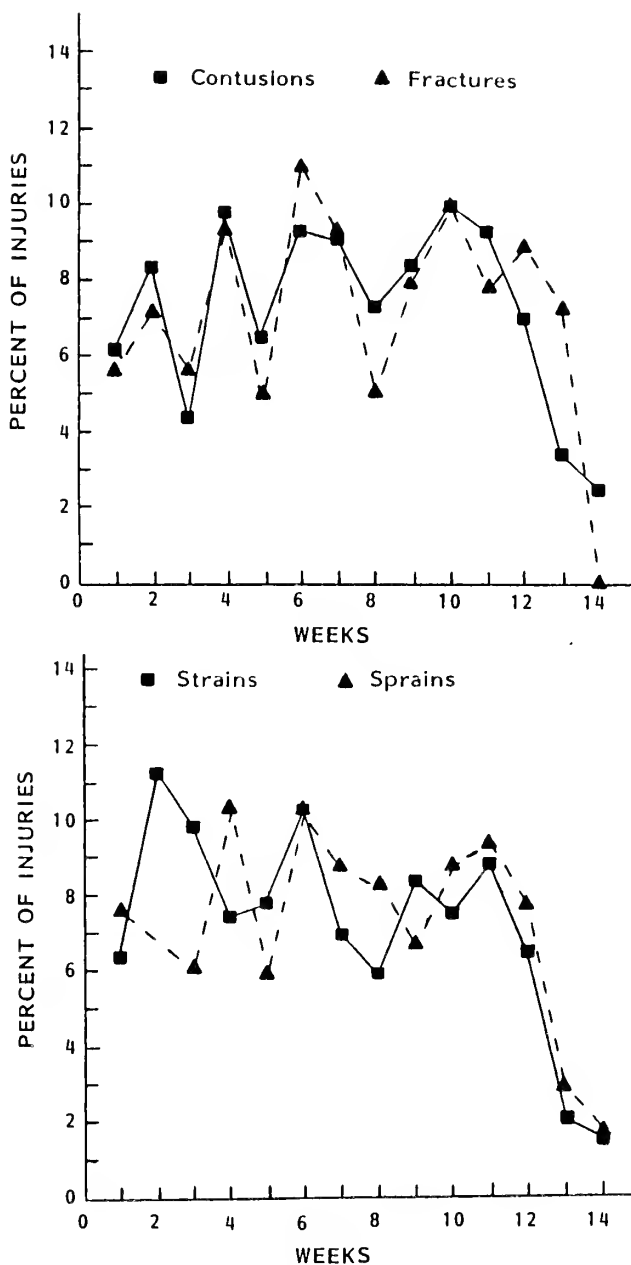


Figure 2. Distribution of common injury types.

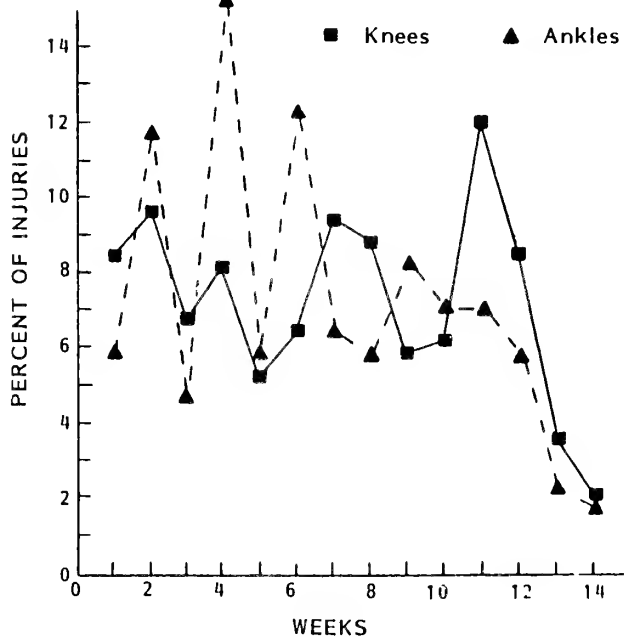
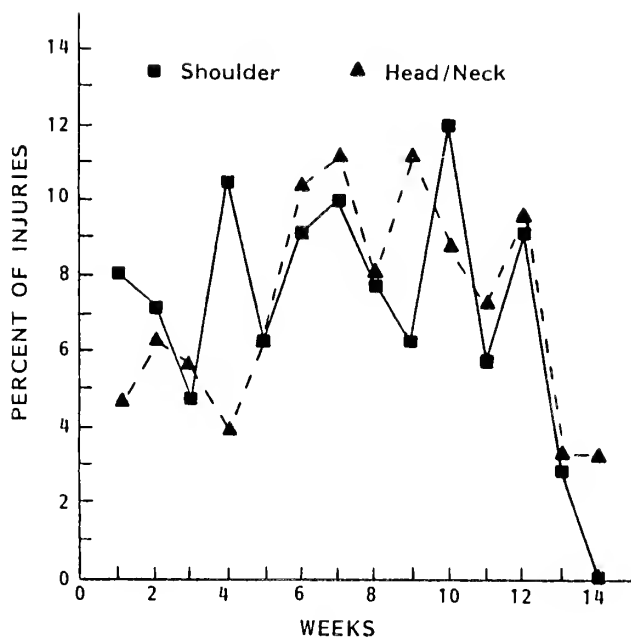


Figure 3. Distribution of injuries to common body areas.

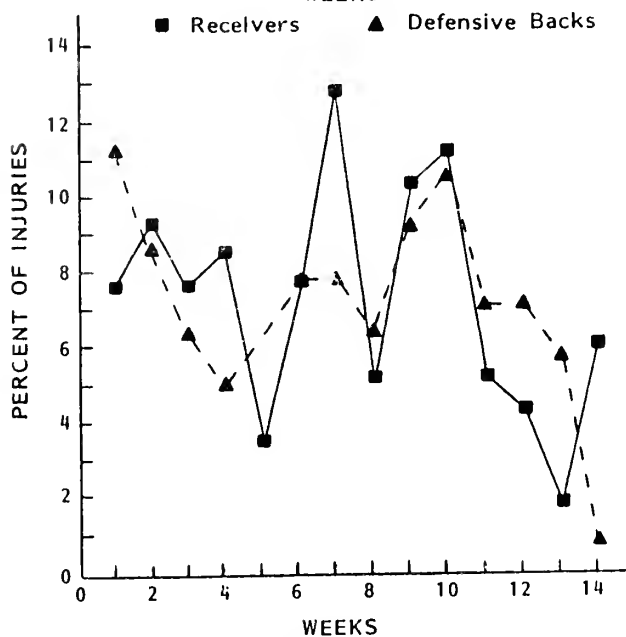
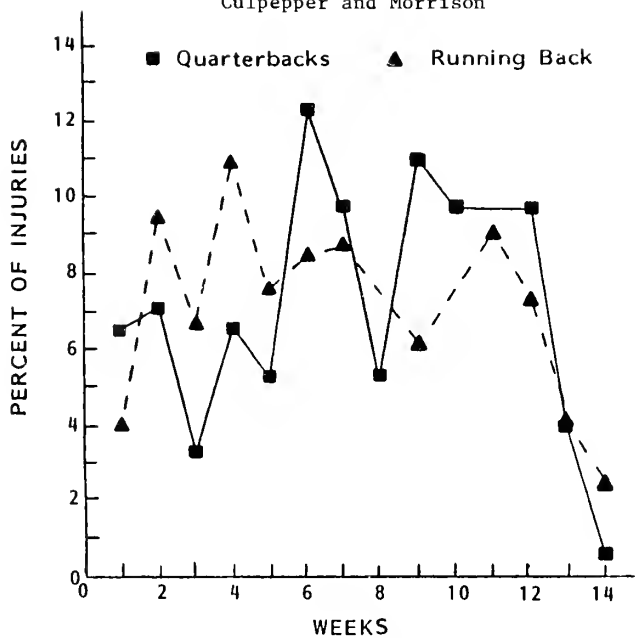


Figure 4. Injuries to quarterbacks, running backs, receivers, and defensive backs.



peak at week six. The number of injuries to running backs was greatest earlier in the season and gradually declined as the season progressed. Injuries to defensive backs were greatest at weeks 1 and 10 whereas injuries to wide receivers were greatest at week 7.

Although descriptive patterns emerge, chi-square analysis revealed no significant differences in injuries that occurred to quarterbacks and running backs and the week of the season that the injury occurred. However, the number of injuries occurring to wide receivers at week 14 was significantly greater than would be expected from the total number of injuries occurring that same week. One explanation for this is that those schools competing for post season competition may have better quarterbacks who throw more than others. Receivers on these teams would be at greater risk for injury. In addition, many receivers are tall and play basketball when the football season ends. As the football season ends and basketball season begins, these athletes would likely seek treatment in preparation for the basketball season.

One third of all injuries occurred to defensive and offensive linemen (Table 3). Figure 5 shows the distribution patterns of injuries to these player positions. Fluctuation of injuries to defensive linemen were greater compared to offensive linemen. However, there were no significant differences in the number of injuries occurring to these player positions and the week of the season that they occurred. Again,

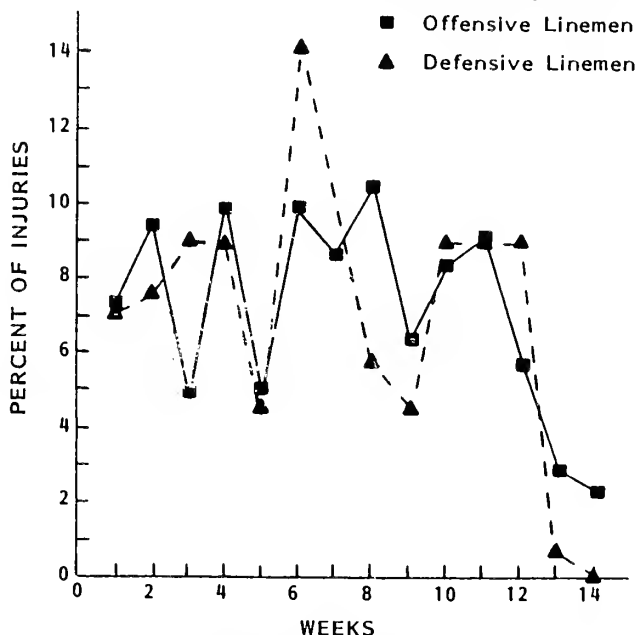


Figure 5. Distribution of injuries to offensive and defensive linemen.

this is likely due to the calculation of theoretical frequencies from the overall distribution pattern.

#### SUMMARY AND CONCLUSIONS

An analysis of 1,623 varsity high school football injuries over a four year period shows a distribution pattern of injuries throughout a 14 week season characterized by weekly fluctuations. When comparing relative frequencies of various injury types, body areas, and player positions, particular distribution patterns can be described. Chi-square analysis revealed that the frequency of injuries occurring to wide receivers on the last week of the season was significantly greater than the frequency distribution of injuries occurring that same week. However, no other significant differences were found. These data indicate that although injury patterns can be described, any particular injury can occur to any player at any time of the season. Therefore, it is important that school officials, coaches, trainers, team physicians, and other health care personnel know that they can expect any type of football injury at any time of the season and need to be prepared to handle these injuries when they occur.

#### ACKNOWLEDGEMENTS

Appreciation is expressed to the Birmingham Monday Morning Quarterback Club and the Crippled Children's Foundation for their support.

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SERUM AND ENDOMETRIAL ASPARTATE AMINOTRANSFERASE, GLUTATHIONE  
REDUCTASE AND THIAMIN TRANSKETOLASE ACTIVITY DURING THE  
NORMAL MENSTRUAL CYCLE OF THE BABOON<sup>a</sup>

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ABSTRACT

The purpose of this study was to determine whether the following coenzyme-dependent enzymes varied in activity in baboon endometrium and serum during normal menstrual cycles: aspartate aminotransferase (AST)-pyridoxal phosphate (PLP); glutathione reductase (GR)-flavin adenine dinucleotide (FAD); and thiamin transketolase (TTK)-thiamin pyrophosphate (TPP). Endometrial biopsies were obtained from 11 baboons under general anesthesia throughout one menstrual cycle and immediately assayed for basal activity of each enzyme and again in the presence of excess coenzyme. The degree of saturation of apoenzyme with coenzyme was calculated from the differences in these two activities. Endometrial protein and dry matter content were also determined. Endometrial AST activity in the presence of excess PLP was significantly ( $P < 0.05$ ) elevated during the luteal phase of the menstrual cycle. The degree of saturation with PLP was lowest during this time ( $P < 0.05$ ). Endometrial GR activity was also highest during the luteal phase ( $P < 0.01$ ) but endometrial TTK activity did not change. Saturation by coenzyme increased steadily throughout the cycle for both GR ( $P < 0.05$ ) and TTK ( $P < 0.005$ ). In serum, only GR, lowest at midcycle ( $P < 0.05$ ), and TTK, lowest just prior to ovulation ( $P < 0.005$ ) fluctuated significantly during the cycle. These results suggest potential relationships between these enzymes, their coenzymes and cyclic hormonal patterns during menstruation.

INTRODUCTION

The metabolism of human endometrium has been extensively studied and reviewed (7,13,27,30,31). The relationships between specific endometrial enzymes and endogenous estrogen and progesterone levels during normal menstrual cycles (15,29) and amenorrhea (13,14,26) have been demonstrated. However, due principally to difficulties inherent in designing adequately controlled studies using human volunteers and limitations due to biopsy sampling, in particular among normal patients, definitive and sophisticated subcellular studies have been hindered.

<sup>a</sup>Manuscript received 13 April 1987; accepted 26 June 1987.

## Menstrual Cycle of the Baboon

In recent years, the histology, cytochemistry and limited enzymology of baboon endometrium has been described (6,10,11,12,17). This study was conducted in the baboon to determine if a systematic pattern of change in activities of aspartate aminotransferase (AST), glutathione reductase (GR) and thiamin transketolase (TTK) could be described in serum and/or endometrium during the course of normal menstrual cycles. Since these enzymes require coenzymes for their actions, potential relationships between apo- and coenzyme were also studied throughout the cycle.

### MATERIALS AND METHODS

#### *Baboons*

Eleven mature female baboons (*Papio anubis* and *cynocephalus*), previously acclimated to captivity, were maintained individually in metabolic cages at 24°C and with 12 hours each of light and dark. They were fed Monkey diet (Wayne Feeds, Chicago, IL) and water ad lib, weighed between 10 and 25 kg and had all been handled and bled by venipuncture routinely without anesthesia. As evidenced by changes in perineal turgescence, each baboon was sexually mature and cycling normally (6,23).

Blood samples were obtained weekly throughout one normal cycle by venipuncture of the cephalic vein in either arm and without the use of anesthesia. All samples were allowed to clot and subsequently centrifuged, the serum collected and stored at 4°C until assayed (generally within 24 hours). Endometrial biopsies were obtained over a three month period to establish baseline enzyme data for normal menstrual cycles. Prior to performing the biopsy, each baboon was anesthetized with ketamine hydrochloride 10 mg/kg, IM (Parke-Davis) and placed on an adjustable operating table in a dorsal recumbent position. The perineum was washed, the cervix visualized and the cervical canal dilated to 6 mm. The biopsy, averaging  $25 \pm 18$  mg, was then obtained with a Novak endometrial biopsy suction curette (Durr-Fillauer Medical, Inc., Homewood, AL). The biopsies were then placed in ice-cold saline until processed about two hours later. The entire procedure required about 20 minutes. All these enzymes were shown to be stable for at least 48 hours in both blood and endometrium when stored at 4°C.

#### *Assays*

Biopsy samples were divided, one portion processed for dry weight determination and the other portion homogenized in 1-2 ml of 0.01M potassium phosphate buffer, pH 7.4. Protein content in each tissue sample was determined by the method of Bradford (8). The activity of the three apoenzyme-coenzyme systems were determined by the methods of Bayoumi and Rosalki (4). These methods are based on the measurement of aspartate aminotransferase (E.C.2.6.1.1.), glutathione reductase (E.C.1.6.4.2) and thiamin transketolase (E.C.2.2.1.1) activities. Both the activity of each enzyme and the degree of saturation of each enzyme by the respective coenzyme were determined in endometrium and serum.

*Data Analysis*

Data were summarized as the mean plus or minus the standard error of the mean. The data were analyzed by a repeated measures analysis of variance to compare cycle stage<sup>25</sup>. Individual comparisons between cycle means used Fisher's protected least significant difference test<sup>25</sup>. Differences were declared statistically significant if  $P < 0.05$ .

The dating of each blood sample and biopsy was done retrospectively because the time of ovulation cannot be accurately predicted. However, ovulation time can be estimated by observing perineal area changes throughout the cycle. The perineal area of the baboon swells during the menstrual cycle and the degree of swelling (turgescence) is a useful indicator of the stage and normalcy of each cycle. During the first half of the cycle estrogen levels rise and the estrogen-dependent sex-skin or perineal area swells simultaneously, peaking during the peri-ovulatory period. After ovulation, the corpus luteum synthesizes increasing amounts of progesterone which causes detumescence of the sex-skin by approximately 2 days after ovulation.

The menstrual cycle data were grouped in five to eight day groups based on the approximate day of ovulation (day zero) and the hormonally dynamic periods of the cycle. The mean length of menstrual cycles in this study was 32.6 days (range 25 to 42 days). This agrees well with an earlier report which demonstrated that anesthesia and endometrial biopsy did not alter the baboon's menstrual cycle (6).

## RESULTS

Endogenous AST activity did not vary during the menstrual cycle but when excess PLP was added to endometrial homogenates, activity increased significantly ( $P < 0.05$ ). Highest levels of AST activity were observed late in the luteal phase. The inverse was observed for coenzyme saturation of AST. The level of saturation by coenzyme decreased significantly ( $P < 0.05$ ) from a high of nearly 100% early in the cycle to a low of 60% late in the luteal phase. These observations were consistently similar whether AST activity was expressed in terms of wet tissue, dry matter content or protein content (Fig. 1).

Both endogenous and total endometrial GR activity were lowest during day group -8 to -4 of the menstrual cycle and were significantly elevated ( $P < 0.01$ ) in day group >10. The degree of saturation by coenzyme followed an identical pattern, being 70% saturated early in the cycle and 97% saturated late in the cycle ( $P < 0.05$ ). Again, observations were similar regardless of whether activity was expressed relative to wet weight, protein or dry matter content (Fig. 2).

Endogenous and total endometrial TTK activity did not vary significantly during menstruation. Saturation of TTK by coenzyme increased steadily ( $P < 0.05$ ) from 83% early to 99% late in the cycle (Fig. 3).

The activity of AST in packed red blood cells did not vary during the menstrual cycle. Erythrocyte GR activity was lowest at midcycle

## Menstrual Cycle of the Baboon

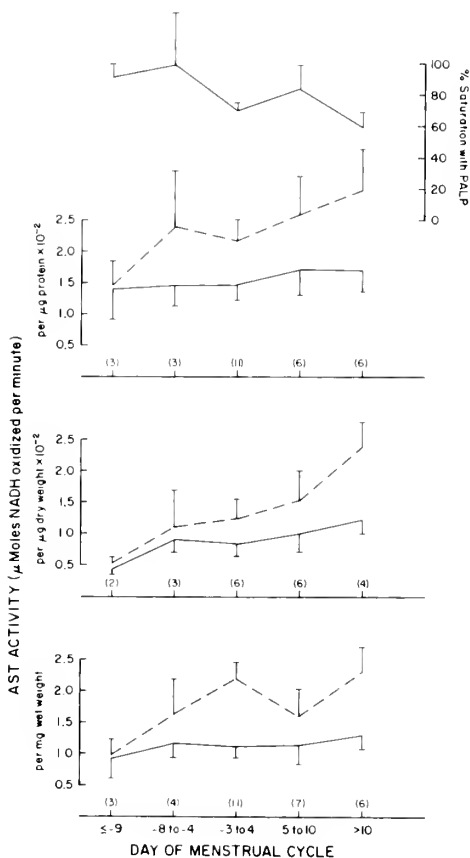


Figure 1. Aspartate aminotransferase (AST) activity (means  $\pm$  SEM) in endometrial biopsies throughout a normal menstrual cycle in 11 baboons. Day zero was the approximate day of ovulation. The solid line is endogenous AST activity and the dashed line total enzyme activity as determined in the presence of excess PLP. The number of samples in each mean is indicated in parentheses.

( $P < 0.05$ ), while TTK activity and saturation with thiamin pyrophosphate were lowest in day group  $-8$  to  $-4$  ( $P < 0.05$ ). These data are shown in Fig. 4.

## DISCUSSION

The purpose of these studies was to provide preliminary information leading to a better understanding of the role of coenzymes and their

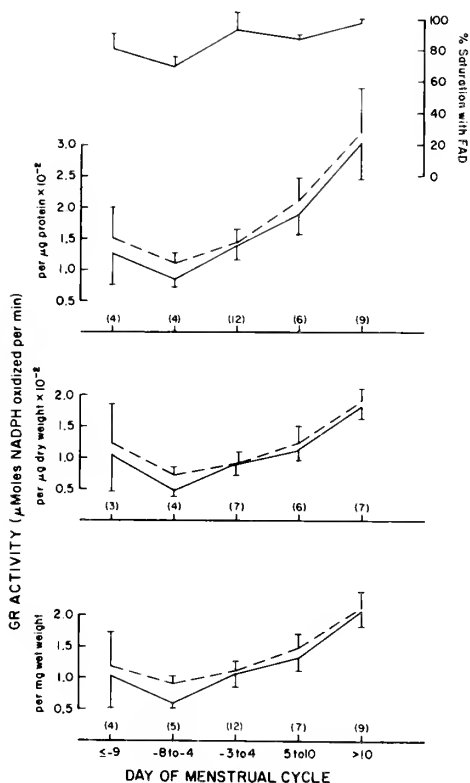


Figure 2. Glutathione reductase (GR) activity (means  $\pm 1$  SEM) in endometrial biopsies throughout a normal menstrual cycle in 11 baboons. Day zero was the approximate day of ovulation. The solid line is endogenous GR activity and the dashed line total enzyme activity as determined in the presence of excess FAD. The number of samples in each mean is indicated in parentheses.

apoenzymes in relation to endometrial metabolism in a model animal, the baboon, which has been shown to be similar to the human in many aspects of reproductive biology and endocrinology (<sup>10,11,12,16</sup>). Each of the enzymes studied required the presence of a coenzyme and each plays a role in metabolic pathways known to be important in uterine metabolism. Aspartate aminotransferase requires PLP, the coenzyme form of vitamin B6, is involved in numerous transamination reactions and decarboxylations and has been shown to respond to estradiol (<sup>5</sup>), ethinylestradiol and norgestrel (<sup>32</sup>) in the uterus. This coenzyme is also proposed to be a structural component of the muscle phosphorylase enzyme which dephosphorylates glycogen (<sup>2</sup>), a major secretory product of endometrial metabolism.

# Menstrual Cycle of the Baboon

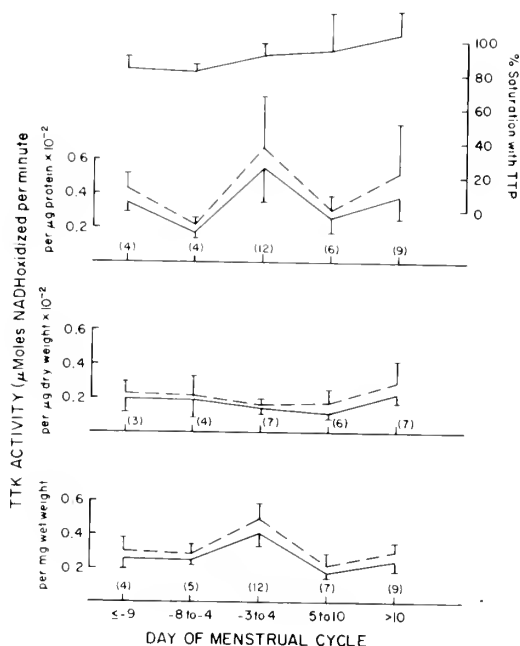


Figure 3. Thiamin transketolase (TTK) activity (means  $\pm 1$  SEM) in endometrial biopsies throughout a normal menstrual cycle in 11 baboons. Day zero was the approximate day of ovulation. The solid line is endogenous TTK activity and the dashed line total enzyme activity as determined in the presence of excess TPP. The number of samples in each mean is indicated in parenthesis.

Glutathione reductase requires FAD, the coenzyme form of riboflavin, for its role in oxidative enzyme systems. Prostaglandin synthesis also requires GR and it may be involved in the endometrial synthesis of prostaglandins.

Thiamin transketolase requires TPP, the coenzyme form of thiamin, for its action in hexose monophosphate metabolism. Since this pathway has been shown to be stimulated in the uterus by estradiol (<sup>3</sup>), the activity of TTK and the disposition of its coenzyme are important.

Several important observations were made in the present study. During normal menstrual cycles the total amount of AST present in the endometrium increased but because interaction with coenzyme was diminished, there was no apparent change in endogenous AST activity. This decline in saturation by coenzyme could be due to altered availability of coenzyme or inhibition of complex formation with the apoenzyme. En-



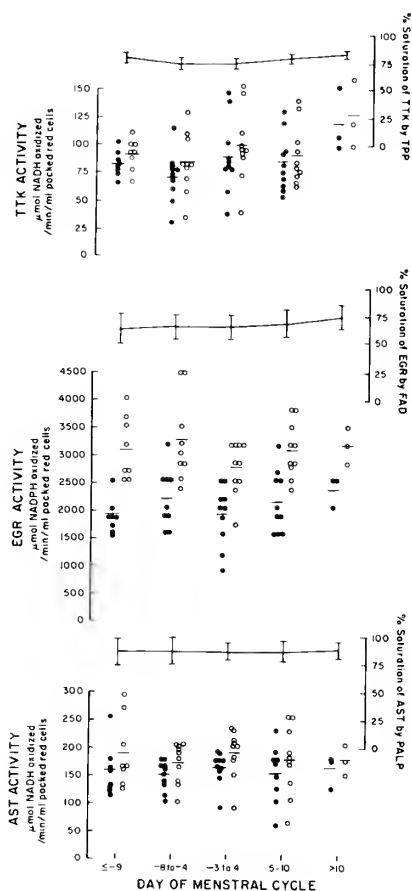


Figure 4. AST, EGR, and TTK mean activity during a control menstrual cycle for 10 baboons. The menstrual cycle day-groups are approximately 1-week intervals beginning 2 weeks before ovulation (ovulation occurs at day zero). Open and closed circles represent enzyme activity with and without coenzyme supplementation, respectively. The line graph indicates the degree of saturation (mean  $\pm$ SD) of each apoenzyme by its respective coenzyme.

ogenous GR activity and total enzyme increased in the endometrium but in this case, saturation by coenzyme also increased. While TTK activity was unremarkable during the menstrual cycle, saturation by coenzyme increased.

The activities of these enzymes in the blood did not always parallel those in endometrium. There were not significant changes in blood AST parameters while endometrial AST parameters were altered. Blood and endometrial GR activity were both lowest in the mid-to-late follicular phase and highest during the luteal phase while saturation of TTK by its coenzyme was highest in both tissues in the late luteal phase and lowest prior to ovulation.

Whether any of these changes were caused by either estrogen or progesterone is not known at this time, but estradiol<sup>(5)</sup> and synthetic steroids<sup>(32)</sup> have been shown to increase AST activity. Sex steroids have also been shown to alter PLP interaction with other PLP-dependent enzymes<sup>(18,19)</sup>, as have synthetic steroids<sup>(1,24)</sup>. Other studies have suggested the existence of modifiers of steroid hormone receptor binding or activation. Pyridoxal-phosphate has been suggested as a modulator of rat liver glucocorticoid receptor complex and can interfere with rat uterine estrogen receptor.<sup>(20)</sup> Pyridoxal phosphate has also been reported to interfere with both activation and nuclear binding of uterine receptor-estrogen complex by forming Schiff bases<sup>(21,28)</sup>.

Each of these enzyme-coenzyme systems has been shown to be active in the uterus and possibly related to hormonal changes during the menstrual cycle. The exact nature of these relationships remains to be elucidated.

#### ACKNOWLEDGEMENT

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ECONOMIC DEVELOPMENT AND THE  
FUTURE OF ALABAMA<sup>a, b</sup>

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INTRODUCTION

Questions of American economic vitality and innovation have reached a high level of broad discussion throughout the nation. All segments of society have an important stake in economic renewal. Industrial and commercial competitiveness on a global scale are crucial to our economic and social well-being.

Over time, the economic strength of Alabama will be dependent on whether this state is a player in the developing long-run national and global trends. Alabama has many natural resources, and wealth creation is, in part, a function of natural resources; but it is more. It is also a function of ideas, aptitudes, and attitudes. If the people of Alabama are to enjoy higher standards of living and improvements in the quality of life, then this state must be competitive. To become more competitive, there must be a concerted effort by responsible leadership from government, education, and private enterprise.

This paper is not a call for a form of centralized state planning wherein government targets winners and losers. That is best left to the profit and loss calculus of the market or else new ideas will be smothered in the bud, and inefficiencies will erode both actual and potential wealth creating activities and attitudes. Indeed, an economic climate conducive to diversified risk-taking ventures is essential. Such a scenario helps to give birth to home-grown industry as well as attracting industry into this state.

The primary purpose of this paper is to provide information which is relevant for economic development strategy. In developing criteria for selecting industries, a number of factors should be considered. Certainly, prime considerations are the area inventory of resources, including the quantity and quality of both natural resources and labor, the available social infrastructure (transportation arteries, school systems, community recreational facilities, etc.), and industrial facil-

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<sup>b</sup>A preliminary draft of this paper was presented at the March, 1987 meeting of the Alabama Academy of Science. The authors are respectively, Research Professor of Business and Economics and Holder of the Adams-Bibby Chair of Free Enterprise, Sorrell College of Business, Troy State University.

ities. Industrial site location decisions are based on considerations such as expected production and transportation costs necessary to produce goods and move them to markets. Other considerations are also important. It has been noted that neither pure theory nor econometrics alone is sufficient for explaining why multinational firms locate where they do.<sup>1</sup> Business environment, lifestyle conditions, and employee work attitudes are significant factors.

### A FRAMEWORK FOR EVALUATING ALTERNATIVES

Certainly, the enhancement of employment and earnings opportunities is of vital importance. Estimating multiplier effects of various types of industry provides important additional information in selecting alternative courses of action for development strategy. In this regard, one mechanism that can be utilized to measure the total impact of a change in economic activity is the input-output model. Such a model yields estimates of the effects which new jobs and earnings in a new plant or firm have on total incomes and employment via interindustry interactions. This phenomenon is commonly referred to as the multiplier effect; i.e., the effect of an initial change in employment or payroll earnings by a single firm on total employment or earnings is a multiple greater than one.

It is reasonable to assume that most of the new jobs which will be created in Alabama during the next five years will be in industries already located here. Given this assumption, an important question is which of the existing industries are most likely to respond to development efforts? There are limits to what can be done; i.e., money would not be wisely appropriated in attempting to bolster or retain fading industries.

A second relevant question is which economic sectors or subsectors are most important in generating incomes and employment? A related, but somewhat different, and perhaps even more important question is which sectors or subsectors have the largest relative marginal impacts on total earnings and employment for the state? Another way of asking the latter question is which industries are likely to generate the largest increases in incomes and employment.

Two types of quantitative measures can be of use to agencies in setting priorities regarding economic development efforts. First, employment and earnings multipliers developed from input-output models provide measures of projected income and employment generating capabilities of various industries.<sup>2</sup> Generally, the higher the percentage of sales dollars a sector spends on goods and services from other sectors in Alabama, the higher its earnings and employment multipliers.

Included among the earnings multipliers computed by the Center for Business and Economic Services at Troy State University for selected economic sectors are 2.91 for food and tobacco products, 1.94 for fishery and forestry products, and 1.54 for lodging and amusements. An earnings multiplier means that for every 100 dollars spent, for example, in the lodging and amusements sector, total earnings in the state increase by 154 dollars.

Similarly, included among the employment multipliers computed by the Troy State Center are 3.46 for food and tobacco, 2.39 for fishery and forestry products, and 1.34 for lodging and amusements. As an example for interpreting an employment multiplier, for every 100 jobs created in the fishery and forestry products sector, a total of 239 jobs are created in Alabama because of interindustry impacts.

A second type of quantitative measure of the potential contribution to growth by various industries are projected growth rates of those industries. Such projected growth rates can be estimated from forecasts completed in 1985 by the Division of Economic Growth of the Bureau of Labor Statistics in the U.S. Labor Department. These projections are of real output, number of hours worked by employees, total employment in the industry, and employment of persons drawing wages and salaries in each industry. Projected growth rates for the 1985-95 period in real output for more than 100 industries have been computed. Growth rates by industry range from a high of 8.39 percent for computers and peripheral equipment to a low of negative 3.42 percent for wooden containers. Selected industries with growth rates falling within the maximum and minimum rates include 4.23 percent for amusements and recreation services, 3.59 percent for banking, 3.49 percent for hotels and lodging places, and 2.07 percent for food products.

Thus far, three different rankings of industries or industry sectors have been presented; two are based on earnings and employment multipliers, and one is based on projected annual growth rates. This paper presents a method of combining the multipliers and the growth rate of each industry to produce a multiplier (one for employment and one for earnings - though only employment multipliers are presented herein) weighted by growth prospects for each industry. The Center for Business and Economic Services at Troy State computed the projected compound annual growth rate, the sector employment multiplier, and the growth weighted multiplier for more than 100 industries. Table 1 presents these data for selected sectors.

Calculation of the growth weighted multipliers is accomplished as follows. First, time horizon is selected. In this paper, a five-year horizon was chosen for two reasons. One is that growth projections developed by the Bureau of Labor Statistics are likely to be more accurate for a five-year interval than for longer time periods. The accuracy of longer projections has become suspect due to the anticipated and accelerated rates of technological change. The second reason for a five-year horizon is that it is felt that a shorter time interval would understate the medium term effects of anticipated significant trends in employment and output in particular industries. Risks will have to be incurred in any development decisions. However, given finite knowledge, it seems prudent to seek information which hopefully will lead to wiser choices.

Having selected a time horizon, the next step is to use the compound annual rate of growth or decline for projected employment by sector to calculate the proportion of 1984 employment levels which are expected to exist in 1989 in the industry. This is accomplished by



Table 1. Projected National Compound Annual Growth Rate In Total Employment, Alabama Employment Multipliers, And A Five-Year Growth Weighted Employment Multiplier For Alabama By Industry, 1984-89.

<u>Industry</u>	National Compound Annual Growth percent	Alabama	
		(Type II) Employment Multiplier (no. of many-years)	Growth Weighted Employment Multiplier
Grain mill products	-0.14	3.46	3.44
Canned & frozen foods	-0.39	3.46	3.39
Food products, nec	-0.60	3.46	3.36
Meat products	-0.79	3.46	3.33
Bakery products	-1.38	3.46	3.23
Electric utilities, public & private	1.49	2.98	3.21
Paper products	-0.11	3.18	3.16
Dairy products	-2.30	3.46	3.08
Gas utilities	0.08	2.98	2.99
Industrial inorganic & chemicals	0.15	2.85	2.87
Agricultural chemicals	0.00	2.85	2.85
Wholesale trade	1.55	2.57	2.78
Petroleum refining & related products	-0.70	2.85	2.75
Crude petroleum & natural gas	0.13	2.61	2.63
Forestry and fishery products	0.46	2.39	2.44

Table 1. cont.

Iron & steel foundries & forgings	-0.72	2.38	2.30
Guided missiles & space vehicles	2.17	2.03	2.26
Transportation equipment, nec	1.92	2.03	2.23
New construction	1.03	2.09	2.20
Computers & peripheral equipment	3.67	1.82	2.18
Transportation services	3.49	1.81	2.15
Blast furnaces & basic steel products	-2.24	2.38	2.12
Educational services	0.98	2.00	2.10
Textile mill products, nec	-1.77	2.26	2.07
Plastic materials & synthetic rubber	-0.64	2.13	2.06
Banking	0.96	1.45	1.52
Hotels & lodging places	1.68	1.34	1.46

## Sources of Data:

Projected national compound annual growth rates by industry are based on U.S. Department of Labor, Division of Economic Growth, projections as published in the *Monthly Labor Review* of November, 1985.

Type II employment multipliers for Alabama were developed in an input-output study by the Center for Business & Economic Services, Troy State University. (See bibliography)

Growth weighted employment multipliers were developed by M.R. Holmes of the Center for Business & Economic Services, Troy State University.

adding the projected compound annual growth rate in employment to one and then compounding that five years into the future (if the growth rate is negative, it would be subtracted). For example, if employment in an industry is projected to grow at a rate of one percent per year, then  $(1.01)^5$  is calculated. The answer, 1.051, is multiplied by the sector employment multiplier to get a growth-weighted multiplier. In our example, if the particular industry had a sector multiplier of 2.0, the growth-weighted multiplier would be 2.102. This yields an estimate of the employment effects realized five years hence as a result of adding one job in the industry today. The estimate takes into consideration both the current multiplier and projected growth or decline in employment in the industry. For example, if the growth weighted multiplier of industry X in Alabama is 2.102, then for every 100 jobs added in that industry in Alabama, the total number of jobs created in the state would be 210. Similarly, for every 1,000 jobs added, total employment would increase by 2,102. The growth-weighted multiplier effect for industry X results from a twofold reason. First, industry X realizes internal growth, and second industry X buys inputs from other Alabama industries.

Use of the growth-weighted multiplier provides information that otherwise is not apparent. For example, even though there are projected declines in employment in the food processing industry (largely due to increasing productivity), the employment multiplier for the food processing sector more than offsets the negative employment growth rates. Therefore, food processing is an industry which seems to hold bright economic prospects for Alabama. Inasmuch as the food processing industry is in a period rapid structural change with an increasing proportion of its product being frozen and/or designed for fast and convenient preparation, this industry should be a prime candidate for development efforts in Alabama.

The increased demand for poultry has been significant during the past three decades. During the period 1950-55, per capita consumption of poultry was 26.5 pounds compared to 62.7 pounds for pork. However, over the 1980-83 time interval, per capita consumption for pork rose only slightly to 63.6 pounds while that for poultry increased to 63 pounds or an increase of 138 percent. Of the combined per capita consumption of poultry, pork, beef, and seafood, the percentage of the total accounted for from 1980-83 for pork was 29 percent compared to 62.7 percent in the 1950-55 period. Poultry per capita consumption as a percentage of the combined total rose from 17 percent in 1950-55 to 29 percent of the total aggregated consumption of meat, poultry, and seafood in 1980-83. This trend is expected to continue.<sup>3</sup>

The food processing industry in Alabama may indeed have a comparative advantage. This is because unlike other southeastern states, more than 50 percent of agricultural revenues in Alabama come from livestock and poultry rather than from crops. Additionally, poultry production is becoming even more important. Thus, it is expected that broiler production and processing will expand. And we have a vigorous commercial fishing industry as well as the resources needed for fish farming. The growth-weighted multiplier for meat products is 3.33. Thus, for every 100 additional new jobs, 333 total jobs would be added to the economy of Alabama in the future.

Standard and Poor's Corporation has noted that the leisure-time industry is a premier growth sector. Over the decade 1974-84, the compound annual growth rate was 11.9 percent. The future of the industry is further enhanced by favorable demographic factors.<sup>4</sup> The growth-weighted multiplier for amusements and recreational services in Alabama is 1.51. Therefore, for every 100 jobs created, total state employment would be expected to rise by 151 jobs. The impact of expanding this industry would offer additional benefits by helping to increase the state profile and also by helping the state to export a portion of its tax burden. When tourists travel to and/or through Alabama they purchase items at retail and pay sales taxes. The longer they stay, the more profits received by businesses and the more tax revenues received by state and local governments. Also, there would likely be more Alabamians vacationing within the state and spending money here.

It is to be noted that while growth-weighted multipliers are important for developing considerations, they must be used judiciously. Multiplier effects will be positive when industry expands and negative when industry contracts. For example, in the case of Louisiana the employment multiplier effect of a segment in the energy industry will engineer huge employment dividends when the energy industry prospers, and conversely when the industry nosedives.

#### OTHER CONSIDERATIONS

Developing a diversified state economy would seem to be an appropriate objective. A dramatic example of lack of diversification is Louisiana with its heavy dependence on gas and oil. In the Pelican State, manufacturers produce drilling equipment, service producers transport oil through pipelines, banks make energy loans, and schools and other public services rely on oil and gas tax revenues. Louisiana now has the highest unemployment rate in the nation.

Diversification should be viewed as a goal worth attaining. However, it is no panacea; there is no guarantee or warranty against economic downturns. Changes in tastes and technology are inevitable and can weaken even a strong economy. Additionally, success is a magnetic attraction for competition. For example, just as the South once attracted the textile industry from New England, the Pacific rim nations have, in turn, become intense competitors in the apparel industry.

It is recommended that consideration be given to attracting national, multinational, and joint venture firms into Alabama. It is essential, however, to balance the recruitment of attracting outside industry with the promotion of home-grown industry.

Also important to Alabama's capacity to engineer economic growth is the further development of infrastructure. In this regard, transportation arteries are essential. According to George Berry, Commissioner of Industry and Trade for the state of Georgia, Hartsfield International is the single most important reason that half of Georgia's economic activity is taking place.<sup>5</sup> On a smaller scale, similar benefits have been

realized by Memphis, Nashville, Charlotte, and Raleigh/Durham. Additional highway development would be conducive to more tourism promotion; and this, in turn, would have as a byproduct a higher state profile. As an example, the impact of a multilane, limited access highway system between Atlanta and Texarkana could be substantial; much of the system already exists in Alabama. Less than 300 miles need be built in Arkansas and Mississippi.

Serious consideration should also be given to more investment in human capital. Education should both help prepare workers and give emphasis to the notion of being flexible and adaptable. To prosper, individuals who seek to enter, re-enter, or continue employment must be fluent in writing and speaking English. The accelerated rate of technological change and the growing importance of service sector employment will require workers to learn throughout their careers. There will be a continually decreasing number of workers who can learn one trade well and be set for lifetime employment. The work force must be prepared for the industries of the future. Concerning the vital importance of attracting new industry, William Winter, chairman of the 1986 Commission on the Future of the South and former governor of Mississippi, has stated that education is the single most important element. Similar statements have been made by H. Ross Perot, founder of Electronic Data Systems in Dallas and chairman of a blue ribbon education commission in Texas, and George Berry, the Georgia Industry and Trade Commissioner.<sup>6</sup>

Alabama must more fully utilize vocational schools, community colleges, senior colleges, and universities in economic development roles. They have the resources to help this state both reach and expand its potential. Also, they can provide tailor-made and flexible programs for business. Perhaps educational brokering could improve the match between educational training programs and the needs of business. Advisory Committees composed of professionals and business practitioners are essential to ensure that students in the programs receive marketable skills and competencies. Faculty-industry exchange may be a viable bridge that would yield benefits to both academia and business.

### CONCLUSIONS AND POLICY IMPLICATIONS

Economic weather is always difficult to predict; changes can occur suddenly. But one thing seems certain -- change is bound to occur. It is essential that we in Alabama cultivate a climate conducive to entrepreneurial activity and technological change. The following recommendations are made concerning economic development in Alabama:

1. Growth-weighted multipliers should be considered by development personnel when seeking to promote and/or attract industry. These provide information not contained in projected growth rates of employment or earnings alone.
2. One governmental agency should have as its primary mission the promotion of economic development in Alabama. Consolidating development efforts into one agency should lead to economies of scale.

3. Educational institutions should be more fully utilized in economic development roles. Among other things, this means that they should be utilized more fully to help prepare a globally competitive labor force.
4. A diversified state economy should be developed. Indeed, this must be an ongoing goal of state and local governmental policy, and not an objective that can be forgotten once a reasonable level of diversification is attained.
5. Appropriate infrastructure should be further developed and maintained.

Over time, the economic strength of Alabama will be dependent, in large part, on whether the state is a player in the developing long-run national and global trends. Increasingly more attention must be given to requisite conditions for economic growth and development. An improved image and a higher profile for Alabama seem essential. However, an improved state image must be more than cosmetic. It must be substantive to have the needed lasting effect.

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A NATURAL INTERGENERIC HYBRID MINNOW, *CAMPOSTOMA*  
*OLIGOLEPIS* X *NOTROPIS CHRYSOCEPHALUS*  
(PISCES: CYPRINIDAE)<sup>1</sup>

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ABSTRACT

A natural intergeneric cyprinid hybrid *Campostoma oligolepis* X *Notropis chrysocephalus* is described and compared to its parental species. The grand hybrid index for counts and proportions shows a closer morphological relationship of the hybrid to *Notropis chrysocephalus*. Tables and figures of the parental species and the hybrid are included.

On 20 May 1986, while surveying the fish fauna in Coldwater Creek, Calhoun, Co., AL, an unusual cyprinid fish was collected along with a series of large scale stonerollers, *Campostoma oligolepis* (Hubbs and Green) and striped shiners, *Notropis chrysocephalus* (Rafinesque). The unique individual had such a distinctive combination of characters that it could have been mistakenly described as a new cyprinid genus. However, closer examination revealed that the specimen had some characters intrinsic to *C. oligolepis* while others were like those of *N. chrysocephalus*. Other characters examined were intermediate between the two species. Therefore, we believe that this unique specimen most likely represents an intergeneric hybrid resulting from the cross of *C. oligolepis* X *N. chrysocephalus*. The purpose of this paper is to describe the hybrid morphology in detail and to present some hypotheses on its possible origin.

Hybridization within freshwater fishes is not uncommon (Hubbs, 1955; Schwartz, 1972), especially within the speciose family Cyprinidae. Several authors (Raney, 1940; Hubbs, 1951; Gilbert, 1961) list examples of intergeneric and interspecific crosses involving cyprinids. Schwartz (1972) listed the following crosses involving either *Campostoma anomalum* (no references to *C. isolepis* were cited) or *Notropis chrysocephalus*: *C. anomalum* X *Nocomis leptoccephalus*; *C. anomalum* X *Nocomis micropogon*; *C. anomalum* X *Nocomis platyrhynchus*; *C. anomalum* X *Notropis chrysocephalus*; *C. anomalum* X *Notropis cornutus*; *C. anomalum* X *Phoxinus erythrogaster*; *C. anomalum* X *Rhinichthys cataractae*; *Notropis chrysocephalus* X *Notropis cornutus*; *N. chrysocephalus* X *Notropis leuciodus*; *N. chrysocephalus* X *Notropis rubellus*. Schwartz (1972) lists Lachner's (1971) reference to a cross between *Campostoma anomalum* X *Notropis chrysocephalus*, a similar combination to the cross being considered here.

<sup>1</sup>Manuscript received 30 March 1987; accepted 3 July 1987.



## A Natural Intergeneric Hybrid Minnow

Our hybrid specimen (Figure 1) was taken from Coldwater Creek, in the Coosa River system, approximately 300 meters downstream from its origin at Coldwater Spring, Calhoun Co., AL, T 16S, R 7E, Sec 32. The collection was immediately preserved in 10% formalin. Three subsequent collections from Coldwater Creek revealed no additional hybrids, and very few large (greater than 80 mm SL) specimens of *N. chrysocephalus*. Conversely, large specimens of *C. oligolepis* were taken during each collecting trip. Due to the lack of specimens, means for *N. chrysocephalus* were calculated from only four individuals; the averages for *C. oligolepis* were calculated from 10 specimens.

The hybrid specimen and all other individuals of the parental species used in this study were deposited in the University of Alabama Ichthyological Collection (UAIC 7843).

Measurements and counts given in Table 1 were made following the methods of Hubbs and Lagler (1958). All measurements, except standard length, are expressed as thousandths of the standard length. Ranges and means of parental species are given for both proportions and counts. Table 2 compares external and internal characteristics of *C. oligolepis*, *N. chrysocephalus*, and the hybrid.



Figure 1. A, *Campostoma oligolepis*, 76 mm standard length, UAIC No. 7843.02. B, the hybrid, *Campostoma oligolepis* x *Notropis chrysocephalus*, 86 mm standard length, UAIC No. 7843.03. C, *Notropis chrysocephalus*, 98 mm standard length, UAIC No. 7843.01.

Past authors have placed emphasis on the intermediacy of hybrids between their parental species, concerning all characteristics in which the parental types differ (Hubbs and Kuronuma, 1942; Hubbs, 1955; Bailey and Gilbert, 1960). Intermediate characteristics are not limited to external features, but may include internal characters as well.

In order to quantitatively study the hybrid's intermediacy, a hybrid index proposed by Hubbs and Kuronuma (1942) was applied to the hybrid. This method of analysis assigned *C. oligolepis* a rating of 100, *N. chrysocephalus* was given a rating of 0, with 50 being exactly intermediate. Ratings above 50 indicate a tendency of the hybrid toward *C. oligolepis*, while a rating below 50 suggested a closer similarity with *N. chrysocephalus*.

Table 1. Comparison of *Campostoma oligolepis* and *Notropis chrysocephalus* with the hybrid *C. oligolepis* X *N. chrysocephalus*.

Character	<i>oligolepis</i>		Hybrid		<i>chrysocephalus</i>	
	Range (n = 10)	Mean	Counts & Proportions	Hybrid index	Range * (n = 4)	Mean
Counts						
Dorsal soft rays	8	8	8	100	8-9	8.05
Pectoral rays (both sides)	32-34	32.6	30	0	30	30
Anal rays	7	7	8	60	9-11	9.5
Total scales lateral series	47-53	50.5	43	2.59	41-44	42.8
Scales around caudal peduncle	17-20	28.2	16	47.6	14	14
AVERAGE HYBRID INDEX				42.0		
Proportions**	(n = 10)				* (n = 4)	
Standard length in millimeters	64-86	73.9	88	---	86-102	94.8
Caudal peduncle length	337-412	362	352	16.6	337-362	350
Body depth at dorsal origin	179-225	210	238	49.0	241-282	265
Soft dorsal fin base	090-118	102	102	100	078-122	097
Head length	220-253	234	238	42.8	232-250	241
AVERAGE HYBRID INDEX				52.1		
GRAND HYBRID INDEX				47.1		

\*Only 4 specimens could be captured for measurements and counts.

\*\*All proportions except standard length are expressed as thousandths of standard length.

# A Natural Intergeneric Hybrid Minnow

Table 2. Comparison of *C. oligolepis* X *N. chrysocephalus* hybrid with the parental species.

Character	<i>C. oligolepis</i>	Hybrid	<i>N. chrysocephalus</i>
Inner cartilagenous ridge of lower jaw	Present	Present	Absent
Mouth	Subterminal & horizontal	Subterminal & oblique, but becoming horizontal anteriorly	Terminal & oblique
Breeding tubercles	Present	Absent	Absent
Interradial membranes of dorsal fin with dark melanophores	Present	Absent	Absent
Scattered black flecks along body	Present	Present	Absent
Color of peritoneum	Dark brown-black	Black with silver cast	Light brown
Position of intestine relative to swim bladder	Coiled about swim bladder	Not coiled about swim bladder	Not coiled about swim bladder
Shape of caudal fin	Rounded, slightly emarginated	Pointed with some emargination	Pointed with considerable emargination
Outline of scales appearing as horizontal lines above lateral line	No	Yes	Yes
Scales of lateral series higher than wide	No	Higher than wide but not appearing diamond shaped	Yes
Pharyngeal teeth	0,4-4,0	1,4-4,1	2,4-4,2

The formula for determining the hybrid index is given below:

$$\frac{V(H) - M(1)}{M(2) - M(1)} \times 100 = P$$

V(H) = value of hybrid  
M(1) = mean of *chrysocephalus*  
M(2) = mean of *oligolepis*

As table 1 shows the grand average of the hybrid index is 47.1, representing a tendency toward *N. chrysocephalus*. A few characters show a hybrid index value identical to that of one of the parents. Table 2 reveals an intermediacy of many of the morphological characters examined. A character of special interest in the hybrid was the presence of an inner cartilagenous ridge of the lower jaw. This particular feature and its peculiar morphology is not known in any other cyprinid genus in

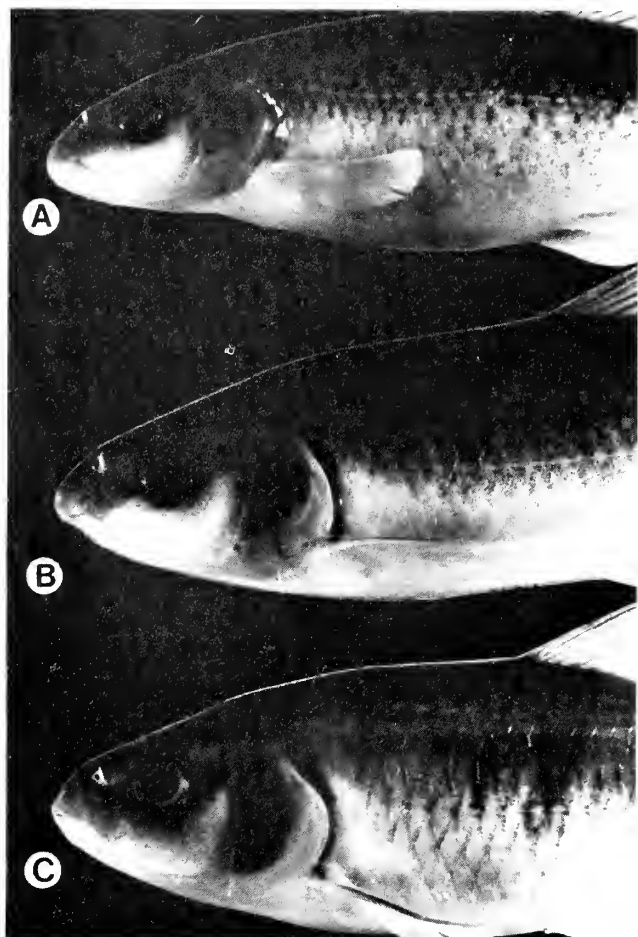


Figure 2. Intermediacy in shape of the mouth of the hybrid *Campostoma oligolepis* X *Notropis chrysocephalus*, and its presumed parents, A, *C. oligolepis* B, hybrid, C, *N. chrysocephalus*.

North America, except *Campostoma*. Another unique character of *Campostoma* is that its intestine is coiled about the air bladder. This characteristic was not present in the hybrid and its morphology was more like that of *N. chrysocephalus*. According to Gilbert (1961), data often are not exactly intermediate concerning hybrid characteristics. The hybrid may resemble the phenotype of one parental species more than the other, indicating a possible dominant influence of one parent (Linder, 1955), while remaining intermediate concerning other characters. However, in general, the recognition of hybrid status on the basis of phenotypic intermediacy is a good diagnostic tool.

All collections made in Coldwater Creek on 20 May 1986, and subsequent dates, were made in pools with gravel raceways leading into the pools. Maximum depth of the pools sampled was approximately one meter. The substrate varied from small gravel and pebbles to sand. According to Smith (1979), this type of habitat is common to both *C. oligolepis* and *N. chrysocephalus*. Water conditions were recorded as relatively clear with moderate flow.

Coldwater Creek has been chemically polluted in the past. The pollution came from a small tributary which enters Coldwater Creek approximately 100 meters below Coldwater Spring. The tributary was contaminated with various chemicals from the Anniston Ordnance Depot, on the Fort McClellan Reservation. Recent cleanup activities by the Army have been successful.

Pollution in the form of industrial waste is piped into the creek approximately 400 meters downstream from its origin at Coldwater Spring. The presence of blue-green algae and a foul smell testify to the presence of organic waste in this section of the creek. The only species collected in this area was *Gambusia affinis*.

*Notropis chrysocephalus* has been known to utilize the nests of other species of cyprinids as well as its own. *N. cornutus*, a closely related shiner with basically the same life history and reproductive behavior as *N. chrysocephalus* (Gilbert, 1979), but with a more northerly range, has been known to spawn over nests built by *Campostoma*. Likewise, *C. oligolepis* often uses nests of other cyprinids for spawning (Miller, 1962). For example Reighard (1943) observed *Campostoma* spawning over a nest built by *Nocomis micropogon*. Since *N. chrysocephalus* and *N. cornutus* have a similar life history and behavior pattern, it follows that in a more southerly range *N. chrysocephalus* interacts with *campostoma* (*C. oligolepis* in the Coosa River system [Burr and Cashner, 1983]), much as *N. cornutus* does in the north.

During the actual spawning act of *N. chrysocephalus*, several males vie for position in the nest. When a female approaches and assumes her position over the nest, gametes are discharged. The fertilized demersal eggs either become attached to the rocks of the nest or are swept downstream along with ununitied sperm. *Campostoma* (in this case *C. oligolepis*) reproductive behavior closely approximates the behavior of *N. chrysocephalus* (Miller, 1962).

We feel that the hybrid was produced by an accidental union of stray gametes from mating frenzies of the two parental species, either over the same nest or from contiguous spawning sites. Also, sperm from one parent could have been swept from an upstream spawning area downstream over the eggs of the other presumed parent. Miller's (1962) and Raney's (1940) description of agonistic nesting territory behavior of *Camptostoma* and *N. chrysocephalus* supports our assumption. Therefore it is doubtful that a female of one parental type consciously engaged in the spawning act with a male of the other parental species to produce this hybrid.

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CRIME IN ALABAMA: THE INITIAL INPUT INTO THE  
CRIMINAL JUSTICE SYSTEM<sup>a</sup>

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INTRODUCTION

The South is changing economically, politically, and socially. This change makes for an interesting study--especially in the area of criminal justice. Certainly one aspect of concern for those interested in this area is crime--the initial input into the criminal justice system.

This study focuses on one state--Alabama--which is often referred to as "The Heart of Dixie." The study concerns itself with the presence of crime in the state, its extent and characteristics, its possible causes, and concludes with some suggestions for coping with it.

A DEFINITION OF CRIME

The term "crime" has been defined as "a positive or negative act committed or omitted in violation of a law forbidding or commanding it."<sup>1</sup> For example, "a person commits criminal homicide if he intentionally, knowingly, recklessly, or with criminal negligence causes the death of another person."<sup>2</sup> States differ in their interpretation of what is criminal. This may account for some of the difficulty that citizens have about criminality. Under the Tenth Amendment to the United States Constitution the states have reserve powers--one of which is the police power--namely, the broad power to regulate the health, safety, and morals of its citizens. Not all of the states exercise this power in the same way. Thus, an individual may legally purchase alcohol in one state under the age of twenty-one, but would not be able to do it in the State of Alabama. Hence, the Tenth Amendment allows for a disparity among states in their definition of criminality. One must remember that state legislatures make most of the laws affecting our citizens--and although there may be similarities among legislatures, certain factors may account for differences regarding the passage of laws affecting criminal behavior. Some of these factors may be: urbanization, religiosity, per capita income, and industrialization. In addition, some parts of the United States may be viewed as "liberal" or "conservative." The South has traditionally been viewed as conservative. In fact, the term "Bible Belt" is often used in reference to certain southern states. It is a term which reflects a conservative way of life. Alabama is the type of state that reflects this conservative trend.

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FELONIES AND MISDEMEANORS

American criminal law is basically concerned with two types of crimes--felonies and misdemeanors. A felony is defined as a serious crime. For example, murder is classified as a felony. This is easily understood in view of the seriousness of the act. A misdemeanor is a crime that is less serious than a felony. It is important to note that the legislature is the public agency that defines felonies and misdemeanors. Hence, an act which may be considered to be a misdemeanor in one state could conceivably be defined as a felony in another state. In addition, in the State of Alabama the legislature has further defined felonies and misdemeanors by various classes. Thus, the state has established "Class A felonies," "Class B felonies" and "Class C felonies." The same is characteristic of misdemeanors. A "Class A felony" is more serious than a "Class B felony."<sup>3</sup>

Conviction of a crime may result in an unpleasant situation for the defendant. For example, conviction of a felony crime results in serious consequences for the violator such as possible imprisonment in a state penitentiary or loss of civil liberties such as the right to vote. In Alabama, there are a number of other possible consequences that may accrue to the repeat offender. For example, "it shall be the duty of any person who has been convicted more than twice of a felony under law of any state of the United States, who has not been restored to his civil rights by competent legal authority, and who resides within any county in the state of Alabama, to register within 24 hours after his arrival in the county, in a book or registration to be kept at the county courthouse, under the supervision of the county sheriff."<sup>4</sup>

Under Alabama law, offenses are classified according to the maximum imprisonment which may be imposed. These offenses are:

1. Violation--a state offense for which a sentence to a term of imprisonment not in excess of 30 days and/or fine as set by the judge may be imposed.
2. Misdemeanor--an offense punishable by imprisonment up to one year in a county jail and/or fine as set by the judge.
3. Felony--an offense punishable by imprisonment in the state prison for more than one year. In addition, a fine may be imposed.
4. Municipal Ordinance Infraction--an offense against a city or town ordinance punishable by up to six months in jail and/or a fine up to \$500.<sup>5</sup>

THE RESPONSE TO CRIME

State and local authorities respond to most of the reported crime in the United States. In comparison, the federal government has jurisdiction over a small amount of criminal activity. However, on occasion it is possible for a state government and the federal government to have concurrent jurisdiction over some criminal activity, e.g., situations

involving bank robbery and many drug offenses. In fact, the federal government's response to crimes which affect local citizens is a substantial help to state and local governments. However, the response to most criminal actions is usually begun by local police who react to violations of state law. Within states, the response to crime also varies from one locality to another. Local criminal justice policies and programs change in response to local attitudes and needs. "For example, the prosecutor in one locality may concentrate on particular types of offenses that plague the local community while the prosecutor in another locality may concentrate on career criminals."<sup>6</sup> In addition, the resources of money and manpower may vary from jurisdiction to jurisdiction and cause a variance in the enforcement of a particular type of law. In theory, a law enforcement officer should respond to all violations of the law. However, reality may dictate that a priority of response be utilized by the police, i.e., the more serious criminal acts receive the most attention by law enforcement personnel.

#### CRIME CONTROL V. DUE PROCESS

The subject of society's response to crime is characterized by debate. Hence, it is not uncommon for students to be introduced in their various readings to contrasting views. One such view is the crime control model which "...assumes that freedom is so important that every effort must be made to repress crime; emphasizes efficiency and the capacity to apprehend, try, convict, and dispose of a high proportion of offenders, and also stresses speed and finality."<sup>7</sup> The crime control model puts a premium on strict law enforcement. It suggests that a failure of authorities to enforce the law results in a dissolution of public order. In order to guarantee social freedom "...the Crime Control Model requires that primary attention be paid to the efficiency with which the criminal process operates to screen suspects, determine guilt, and secure appropriate dispositions of persons convicted of crime."<sup>8</sup> Although the crime control model may be appealing to some individuals, it is not without criticism. For example, the emphasis on strict law enforcement does not seem to recognize the utility of discretion on the part of law enforcement officers. If law enforcement officers were to enforce the law to its fullest extent several practical difficulties might arise. In particular, our judicial system would be so encumbered that its efficiency would be hampered. The cost also would be prohibitive.

As an alternative to the crime control model some individuals have cited the due process model-- "a model of the criminal justice system that assumes that freedom is so important that every effort must be made to assure that criminal justice decisions are based on reliable information; emphasizes the adversarial process, the rights of defendants, and formal decision making procedures."<sup>9</sup> Of course, the due process model is not without criticism. For example, criticism may come about when a person has committed a particular heinous act for which no successful prosecution can come about because of an erroneous technical procedure employed by an investigating officer, i.e., illegal search and seizure.

## ALABAMA POLITICS AND CRIME

Citizens respond to crime in different ways. Of course, politicians are acutely aware of the public's sensitivity to crime. When Alabama's George Wallace sought the Presidency in 1968, one of his major themes was "Law and Order." When Charles Graddick successfully campaigned for the position of Alabama Attorney General years later, one of his major themes concerned the value of strong law enforcement in the state. His theme (emphasizing strong law enforcement) was one that not only is popular in Alabama, but one that is acceptable to residents in other states. Hence, it is politically advantageous for an Alabama politician to capitalize on the concern of Alabama's residents regarding criminal activity.

It is interesting to note that one study has indicated that regardless of the actual rate of crime, the fear of crime today remains as high as it was in the 1960s<sup>10</sup>-- a decade in American history characterized by what many consider to be radical activity resulting from the civil rights movement of the early 1960s--and extending to the end of that decade with the mass demonstrations against America's involvement in the Vietnam Conflict. Although Alabamians did not experience directly police confrontations regarding the Vietnam Conflict as did many residents of some other states, such was not the case regarding the civil rights movement of the early 1960s. The "Montgomery Bus Boycott" as well as the "Selma March" are still vivid reminders to many Alabamians of a turbulent decade in this state's history.

## DETERMINING CRIMINAL ACTIVITY IN A STATE

There are various methods by which the average citizen is able to determine the extent of criminal activity in a state. A popular method results from having the opportunity to read one's local newspaper or the opportunity to view a nightly television news program. It is not uncommon for a crime to receive attention from such elements of the media for a variety of reasons such as the seriousness of the offense or the prominence of the arrested individual. For example, if a local citizen is arrested for driving under the influence--"drunk driving"-- the arrest will usually not be reported to any large extent by the media. Yet, if a prominent individual is arrested for the same crime--there is more of a likelihood that there will be media coverage of the arrest.

## UNIFORM CRIME REPORTS

The Alabama news media not only reports individual criminal acts, but reports also on a regular basis certain trends of criminal activity. This information is often made possible by the Federal Bureau of Investigation through the issuance of its *Uniform Crime Reports*. These reports indicate what types of major crimes are taking place, where they are occurring, and provide an indication of changing crime rates. Eight serious crimes are reported by the FBI *Uniform Crime Reports*: Homicide, Rape, Robbery, Assault (Aggravated), Burglary, Larceny, Motor Vehicle Theft, and Arson. The FBI's *Uniform Crime Reports* for Alabama as well as for other states results from input by various law enforcement agen-

cies. For example, if a city such as Montgomery, Alabama, has twenty-eight forcible rapes reported to the police during a period of time, this information will be made available in the FBI's *Uniform Crime Reports*.<sup>11</sup>

However, as useful as the FBI's *Uniform Crime Reports* are, they do not constitute an exact indication regarding the presence of crime in our society. Several reasons may account for the disparity between reported crime and the amount of crime in our society. For example, it is not uncommon for an individual to refrain from reporting a crime to the police. In addition, citizens may not want the publicity associated with the reporting of a crime, or they may believe that the police would not be successful in the apprehension of the individual who perpetrated the crime. In some cases, citizens may not report criminal behavior to the police because of a fear regarding personal harm. In one national survey of households victims were asked why they had not notified the police of their victimization. "The reason most frequently given for all offenses was that the police could not do anything."<sup>12</sup>

#### NATIONAL CRIME SURVEY

Another source of information for citizens concerning the extent of criminal activity in our society is the National Crime Survey sponsored by the Bureau of Justice. An important difference between the FBI's *Uniform Crime Reports* and the information from the National Crime Survey is that the *Uniform Crime Reports* focus only on reported crime. The National Crime Survey has a broader interest because it concerns both reported and unreported crime. Hence, the figures emanating from each source of information will be different. One author has noted that "the major reason for these large discrepancies, of course, is the fact that significant numbers of these crimes were not reported to the police by victims."<sup>13</sup>

#### THE ALABAMA CRIMINAL JUSTICE INFORMATION CENTER COMMISSION

In 1975, the Alabama legislature passed a law (Act 872) which established the Alabama Criminal Justice Information Center Commission. The Commission collects, analyzes, and disseminates information pertaining to criminal activity in the State of Alabama. "The purpose of the Commission is to establish and operate a statewide criminal justice information system to serve Alabama's criminal justice community--police, prosecution, courts, corrections, pardons, and paroles."<sup>14</sup> The Commission also publishes a yearly report concerning crime in the State of Alabama. The data made available in this report may be used for analyzing crime problems inherent in the criminal justice system as well as for planning and budgetary activity. The statistics compiled in this report are for the state, Alabama's nine Metropolitan Statistical Areas, Sheriff's Offices, municipal police departments, and campus police.<sup>15</sup>

The 1975 law which created the Alabama Criminal Justice Information Center Commission prescribes the following:

## Crime in Alabama

- . All criminal justice agencies in Alabama must report arrests and dispositions to a central location.
- . The ACJIC must establish a uniform crime reporting system for the collection and analysis of reports of criminal activity in Alabama.
- . The ACJIC must establish a complete and accurate file of persons engaged in criminal activities in the State.
- . The ACJIC must establish a system containing all wanted persons, stolen vehicles, and stolen property reported in Alabama.
- . The ACJIC must allow access, review, and challenge by any individual whose record is maintained in the system.
- . The Commission must insure that the necessary measures are taken to provide for the privacy and security of the system.<sup>16</sup>

## PUBLIC PERCEPTION OF CRIME

When *The Birmingham News* polled a sample of citizens concerning the perception of crime the results were not surprising. Crime was mentioned as one of the area's top problems--the second most frequently cited problem after unemployment and economy/lack of growth. *The Birmingham News* quoted one individual as indicating that people today are more aware of crime than in the past because television, radio, and newspapers devote considerable attention to this problem. 'It's a perception kind of thing.' 'All you have to do is have a crime occur in your neighborhood, and your sensitivity threshold is automatically raised. It may be the only crime that's happened in the whole city, but it happened in your neighborhood.' The newspaper article also indicated that of those individuals polled, 42 percent said there was an increase in crime--even though the FBI's 1984 crime figures for the City of Birmingham indicated that crime had dropped in the city by 1 percent for 1983.<sup>17</sup>

The conclusions emanating from the poll conducted by *The Birmingham News* are not surprising. In fact, other studies would probably be in agreement. For example, the Eisenhower Foundation released a study which indicated that 'regardless of actual crime rates,' 'the fear of crime remains as high today as it was in the 1960s. Because they influence how we live and act, fear and perception are important measures of crime.' The Eisenhower study indicated that regardless of the actual crime rate, a recent ABC-TV poll found 86 percent of those sampled believed that the crime rate was on the increase.<sup>18</sup>

According to the Justice Department, the size of a community in which an individual resides affects a citizen's perception of crime. Individuals in a large city (27%) were more likely to perceive an increase in violent crime as opposed to those individuals who resided in a small town (23%) or a rural community (22%). There was a slight difference among the four regions of the United States: Northeast (23%),

Midwest (20%), South (24%), and West (26%). Neighborhoods which were mostly or all white (21%) were less likely to perceive an increase in violent crime than those neighborhoods which are mostly or all black (28%).<sup>19</sup>

Other variables are also related to the perception of criminality. When the question, "And what about the neighborhood where you live, would you say that violent crime is going up or down or what?" was asked of various individuals--a number of interesting responses emerge: females (25%) were more likely to agree than males (22%); blacks (33%) more than whites (23%); respondents with an income less than \$8000 (32%) were more likely to perceive violent crime in the neighborhood increasing than those respondents whose income level was \$30,000 and over (20%).<sup>20</sup>

Even though statistics released by the United States Justice Department in 1982 indicate that the elderly are victimized less than any other age group, police and sociologists suggest that fear of crime may be deeper and more widespread among the elderly than younger victims. Birmingham robbery Sgt. Juanita Evens suggested that the fear of crime comes from some elderly victims when they realize they are unable to protect themselves. She noted that the fear is strongest among those who have been victimized in their homes. Rather than sit on the porch on hot summer afternoons, they may stay inside and keep the doors and windows closed and locked. 'If they can no longer feel safe in their homes, where can they go? That is their last retreat.' Sgt. Evens noted that some elderly women who live alone stay awake most of the night out of fear. She also suggested that some individuals may not be able to move out of the neighborhood because of economic reasons--especially for those individuals living on pensions or Social Security benefits. 'They can't just get out.'<sup>21</sup>

#### ALABAMA CRIME

There were 168,711 crimes reported in 1986, an 8% increase in comparison to 1985, according to the Alabama Criminal Justice Information Center. Alabama's crime rate was 4167.1 per 100,000 inhabitants. The total property value stolen in 1986 was \$126,386,703; 29% was recovered.<sup>22</sup>

Violent crime is of the type that citizens are likely to fear, and it is the type that is likely to receive attention by the media. The Alabama Criminal Justice Information Center designates the following as violent crime: homicide, rape, robbery, and assault. These types of crimes are offenses perpetrated against a person with a high risk of injury or death to the victim. There were 22,016 violent crimes reported in 1986, a 22% increase over 1985. The violent crime rate was 543.8 per 100,000 inhabitants. On the average, there were 60.3 violent crimes reported per day. In 1986, 6,183 people were arrested for violent crimes --93% were adults, 44% were white, and 87% were male. There were 9,940 violent crimes cleared in 1986 for a 45% clearance rate.<sup>23</sup>

## Crime in Alabama

### ALABAMA CLEARANCE RATE

Clearance and arrest data are reported to Alabama officials. The clearance rate in Alabama is achieved by taking the number of clearances over the number of crime reported:

$$\frac{\text{Clearances}}{\text{Reported Crime}} = \text{Clearance Rate}$$

### OFFENSES & CLEARANCES

1986

	OFFENSE	CLEARANCE	CLEARANCE RATE
TOTAL	168,711	36,622	22%
Property	146,695	26,682	18%
Violent	22,016	9,940	45%
Homicide	398	352	88%
Rape	1,122	630	56%
Robbery	4,451	1,261	28%
Assault	16,045	7,697	48%
Burglary	45,629	5,791	13%
Larceny	90,540	18,702	21%
MVT	10,526	2,189	21%

Source: (Alabama Criminal Justice Information Center: *1986 Crime in Alabama*)

In 1986, burglary had the lowest level of clearance while homicide had the highest. It is conceivable that one arrest could clear several offenses. "A crime is considered cleared, either by arrest or by exceptional means, when enough evidence is found to charge a suspect and take him/her into custody."<sup>24</sup> Exactly, how much value there is to using this method of "clearing a crime" is open to debate--especially when the police do not have enough evidence to secure a conviction. In fact, using this method to "clear a crime" may be a factor which causes a police officer to be satisfied with just working to obtain the minimum effort needed to secure an arrest warrant so that the officer will be able to have one more clearance. Since a basic tenet of American Democracy is that a person is presumed to be innocent until proven guilty, perhaps it would be better to refer to a clearance as one which involves convicting a guilty person as opposed to simply arresting an individual who may be completely innocent of the crime.

## CHARACTERISTICS OF OFFENDERS

The Alabama Criminal Justice Information Center distinguishes between Part I offenses and Part II offenses. Part I offenses refer to homicide, rape, robbery, assault, burglary, larceny, motor vehicle theft, and arson.<sup>25</sup> Statistical information relating to those individuals who were arrested in 1986 for Part I offenses (excluding arson) is as follows: 28,803 persons were arrested; 20% were juveniles, 75% were males, 47% were white, and 53% black. There were 154,817 persons arrested in 1986 for Part II offenses --62% were white, and 38% black. A total of 7,004 persons were arrested for narcotic drug violations; 23% were for sale, and 77% for possession. Ninety-five percent were adults and 5% were juveniles.<sup>26</sup>

## POSSIBLE FACTORS AFFECTING CRIME RATES

Although there are various explanations of criminal activity, poverty is not an uncommon factor cited by individuals. In Alabama, the per capita income is lower than that of most states. Hence, the low level of income may be one factor among others that accounts for criminality. A Birmingham survey indicated that the rate of violent crime--murder, rape, robbery, and aggravated assault reported in the city's poorest neighborhoods is ten times greater than in Birmingham's highest-income areas. But Dr. Brent Smith, a criminal justice associate professor at the University of Alabama at Birmingham, was quoted as warning against reading too much into crime statistics. "It's risky to compare individual neighborhoods with one another ... because residents in some areas may feel more confidence in police and be more likely to report crime."<sup>27</sup>

One report which indicated that minorities are most often the victims of violent crimes, as well as the perpetrators, concluded that government policy-makers must give greater attention to such inner-city problems as employment, education, and housing. Hence, more attention should be given to the root causes of crime. The report suggested that while improvements in the criminal justice system are essential, the nation must give more emphasis to 'self-reliant inner-city neighborhood organizations that tie together community prevention, extended family support systems, economic development, and youth employment.'<sup>28</sup>

A number of Alabama professionals have been quoted regarding criminal activity in the state. Although some of their views may not be accepted by all academicians, they are at least interesting and pertinent because these Alabamians have a professional interest in criminal justice. Verne McClurg, Head of the Department of Justice and Public Safety at Auburn University at Montgomery, identified some possible factors which could have accounted for a decrease in crime. For example, the 'baby boom' generation has passed the most crime prone age range, eighteen to twenty-five. He also suggested that when unemployment decreases, this causes the crime rate to be lower. McClurg also noted that generally it is the same criminals, who constitute a small part of the citizenry that are responsible for most of the crimes. With "speedier trials" and "longer sentences," this small group of individuals has less of a chance of committing crime again. McClurg was also quoted as



suggesting that crime prevention programs affect crime because such programs increase public awareness and could be another reason affecting the crime rate.<sup>29</sup>

Various factors were cited to explain Alabama's drop in crime from 1982 to 1983. These factors include: a tough state law, fewer young people, and the public's willingness to get involved in fighting crime. While the Alabama State Attorney General's Office credited the *Habitual Offender Law* as the main reason for few crimes, a federal official cited additional reasons for the decline in crime. 'We've also seen a trend of more support and cooperation with law enforcement from all segments of the public. More people are helping the FBI fight crime'. 'The fear of retaliation and fear of getting involved seemed to have diminished.' The federal official also gave credit to the *Speedy Trial Act* which results in having defendants appear in court sooner while the recollections of witnesses are more accurate.<sup>30</sup>

Janie Nobles, public information officer for the Alabama Attorney General's Office gave credit to "the crackdown on habitual offenders." Ms. Nobles was quoted as saying that 'more and more career criminals are now behind bars so they're not out there to commit criminal acts. About 20 percent of the population commits 60 percent of the crime.' Under Alabama law three felony convictions are required for an individual to be considered a habitual offender.<sup>31</sup> The state's Habitual Offender Act increases prison terms for repeat offenders.

When FBI statistics indicated that there was a decline in criminal activity for part of 1984 in Alabama, various public officials were quoted regarding the decline. Birmingham's Chief of Police, Arthur Deutch, indicated that the city's decline was due to many reasons 'including a professional police force and public cooperation.'<sup>32</sup>

Birmingham Police Inspector B. R. Goforth suggested that the city's decline in the crime rate stems from 'growing community involvement' as well as the crimestoppers program that rewards people who give police tips. Officer Rick Ottman of the Huntsville Police Department noted that 'most of the people you talk to on the street seem to feel they're doing well. Unemployment is way down in Huntsville. That's got to be contributing' to the decline. Montgomery Police Chief Charles Swindall attributed the lower crime rate in that city to good police work.<sup>33</sup>

In 1986, however, it was reported that crime increased in Birmingham for the first time in four years. Birmingham's Chief Deutch attributed the increase to the city's growing boundaries and a shortage of police officers needed to cover the larger geographic area. Deutch was quoted as saying: 'There are many reasons for crime and, of course, even one crime is too much, but we realize that besides being shorthanded last year the city increased in size by one-third.' Deutch also noted an increase in activities which require police service, such as running events and outdoor festivals.<sup>34</sup>

In May of 1987 an Alabama newspaper article entitled "Experts Differ on FBI Crime Index" noted that the FBI's annual crime index, showing changes from 1985 to 1986, indicated a 10 percent rise in the South.

This article also made reference to various professionals in an attempt to explain this increase.<sup>35</sup> For example, "FBI Special Agent Cecil E. Moses speculated that drug addicts and the movement into the South of unemployed people from other areas were the main causes of the increase in the Sun Belt."<sup>36</sup> However, Mr. Brent Smith of the Department of Criminal Justice at the University of Alabama in Birmingham was also quoted as indicating that the FBI figures are better indicators of police activity than they are an accurate estimate of the total volume of crime. Mr. Smith suggested that: 'Police have better recording practices. Also, with an increased emphasis on deterrence, there may be a greater tendency by police to make arrests. Maybe there is a greater law-and-order focus currently. I suspect it is that rather than an actual fluctuation in crime rates.'<sup>37</sup> Mr. John Smykla of the criminal justice school at the University of Alabama in Tuscaloosa indicated that the crime index 'might be more of a measure of crime reporting methods than actual crime itself.'<sup>38</sup> Another individual referred to in the article was Mr. Tom Barker of the criminal justice school at Jacksonville State University. He was quoted as indicating that: "most criminologists don't get excited about the small increases we see year to year. You have to see if there is any long-term pattern to it."<sup>39</sup>

#### VICTIMIZATION

Who are the victims of crime in our society? *The Birmingham News* in May of 1985 made reference to this question. Apparently, males, blacks, the young, the poor, and the unmarried are primarily the victims. Two sources provided this information according to the article: "a five-year series of National Crime Surveys, based on interviews with randomly selected Americans, and five years of reports over the same period, from 1978-82; compiled by the National Center for Health Statistics."<sup>40</sup> The article also noted that for black men, there's a one in twenty-one lifetime chance of being murdered. A white man has a one in 131 lifetime chance of being murdered. In addition, one out of thirty-one Americans over the age of twelve is likely to be a victim of robbery, rape, or assault each year.<sup>41</sup>

#### ALABAMA'S INTEREST IN VICTIMS

Alabama and the nation have come a long way in recent years in regard to the rights of victims. Of course, much more needs to be done. Dr. Marlene A. Young--Director of the National Organization for Victims Assistance (NOVA) indicated that victims of burglarly, vandalism, and arson, as well as some crime witnesses are not helped by victims' aid programs. Dr. Young's remarks were presented in an address at a conference sponsored by VOCAL--Victims of Crime and Leniency. She was critical of the attitudes and practices of many of those who deal with the victims of crime. Governor George Wallace also addressed the group in Montgomery where he blamed the court system for the 'wave of crime' that has hit the nation.<sup>42</sup>

Wallace is not the only individual who has criticized the judicial system. When District Judge Gary McAliley addressed the Enterprise Lions Club, he voiced a similar criticism. 'No one is safe anymore, and

a great deal of the blame for the increase in crime must be laid at the doorstep of the U.S. Supreme Court.' The judge indicated that federal judges today seem to be more concerned about protecting the rights of criminals than they are about protecting the rights of citizens. 'This is illustrated by federal judges, even in Alabama, letting convicted criminals out of the penitentiary because the prison might be unconstitutionally unpleasant.' We cannot solve the crime problem in Alabama or in this country by releasing criminals to get out under new early release programs...<sup>43</sup>

In Alabama, there have been efforts to help out the victims of crime. For example, Mr. Brent Smith offers a course once a year concerning the victims of crimes--who they are and how the criminal justice system is responding to their demands for rights. It is a class which appeals to people who deal with victims in their professional activity--nurses, doctors, and attorneys, and helps them understand the plight of victims. According to Mr. Smith, recent interest in victims has brought about interest in their rights. The groups which are concerned with the rights of victims now provide various services such as counseling and help secure legal services. In addition, some groups have emerged as powerful lobbyists for victims.<sup>44</sup>

According to Mr. Smith, recent gains in victims' rights are helping to balance the scale against offenders' rights. Mr. Smith was quoted as saying: 'I don't think most victims' organizations would want to reduce offenders' rights. Rather they're concerned with ensuring fair treatment for the victim and in making sure there's a balance.' Smith also cited three laws passed by the Alabama legislature in 1983 which help ensure victims' rights: (1) the *Victims Courtroom Attendance Act* which gives victims the right to attend the trials of those they accused, (2) the *Victims Notification Act* which results in the victims being given advance notice that their offenders are released or paroled from prison, and (3) the *Restitution as a final Judgment Act* which provides a means for the offender to repay the victim.<sup>45</sup>

#### "VICTIMS HAVE RIGHTS TOO"

In 1983, there were over thirty states that had programs which allowed victims to receive compensation. These states paid about sixty-eight million dollars to twenty-three thousand victims. It is interesting that a number of tourist oriented states such as Florida and Massachusetts have resisted paying out-of-state residents. However, discrimination against non-residents is now illegal under the 1984 *Victims Assistance Act* which provided a hundred million dollar fund to reimburse states for 35 percent of crime victim awards.<sup>46</sup>

In 1984, Alabama established the Alabama Crime Victims Compensation Commission by legislative action. The law results in an Alabama judge who presides over a felony case to impose a fine of at least \$25 and up to \$10,000 to be used by the Commission to repay victims of crime.<sup>47</sup> However, certain requirements must be met for the Commission to make a payment. For example, to be eligible for payment a victim must have been victimized on or after June 1, 1984. The proper law enforcement

agency must be notified within seventy-two hours, and a claim filed within a year. The victim must be willing to cooperate with the law enforcement agency, and must not have been involved as an accomplice in the crime, and not be convicted of a felony afterward. The maximum paid in any claim is \$10,000 and several victims have received the maximum award. From February (the first month of payments) through November of 1985, it was reported that \$334,000 was awarded to victims. Although 105 victims received compensation, thirty-two were denied claims.<sup>48</sup>

When the Office of District Attorney for Russell County, Alabama, hired a Phenix City police officer as a victims' assistance officer to help those who have suffered from violent crime--District Attorney Ken Davis was quoted as saying: 'that represented a great leap forward for victims in Alabama,'; 'This recognizes that victims deserve the consideration of the criminal justice system.' Davis also added: 'Victims have rights, too.'<sup>49</sup>

#### THE PREVENTION OF CRIMINALITY

Some years ago, a number of interesting suggestions were put forth regarding the prevention of criminal activity. For example, perhaps we should redefine exactly what should be criminal in our society. Specifically, it may mean that some activities which are considered criminal today should be decriminalized. The value of decriminalization is not new to this country as we know by studying the effect of the twenty-second amendment which repealed prohibition. In addition, "a few states now deal with public drunkenness by recognizing alcoholism for what it is, a disease, and not a crime."<sup>50</sup>

Secondly, our legislators should recognize the connection between an environment and crime. This suggests initiating programs which have the effect of lowering the crime rate. Obviously, this is not a goal that is easily attainable. Yet, more could be done in the area of emphasizing employment opportunities--especially for our young people who are most likely to constitute the crime-prone group of citizens. The connection between poverty and crime is too obvious to be ignored by our policy decision-makers.<sup>51</sup>

Thirdly, there should be an emphasis on public works improvement, recreational opportunities, and neighborhood organizations. The federal government can do much in this area, because it has the financial resources to improve our cities and neighborhoods through various types of grant programs. "We must keep in mind that the best resource in our fight against crime is a strong and stable neighborhood."<sup>52</sup>

Of course, "criminals must also be put on notice that they are responsible to their victims."<sup>53</sup> Specifically, it would be advantageous to work toward the certainty of apprehension and punishment resulting from criminal behavior. Yet that is not enough. It would help if the offender can make adequate restitution to the victim as a result of having the opportunity to engage in employment after incarceration or during a release time program.<sup>54</sup> Alabama's Victim Compensations Program is a good start in this area.

FOOTNOTES

<sup>1</sup>Michael M. D'Auria, Gary D. Hefland, and Herbert R. Ryan, *Legal Terms and Concepts in Criminal Justice* (Wayne, New Jersey: Avery Publishing Group Inc., 1983), p. 30.

<sup>2</sup>*Alabama Criminal Code* 13A-6-1. See also: *Criminal Code of Alabama*. Title 13A, issued by Office of the Attorney General, March 1, 1985, p. 32. (Replacement Volume 1982, and 1984 Cumulative Supplement, p. 32).

<sup>3</sup>*Criminal Code of Alabama*. Title 13A, issued by the Office of the Attorney General, March 1, 1985, pp. 32-35. (Replacement Volume 1982, and 1984 Cumulative Supplement, pp. 32-35).

<sup>4</sup>*Ibid.*, 13A-11-181, p. 105.

<sup>5</sup>*State of Alabama. Victim-Witness Handbook*, Ronald L. Meyers, District Attorney, 37th Judicial Circuit, Lee County, Alabama, p. 1.

<sup>6</sup>Much of the information for this paragraph came from the following source: United States Department of Justice, Bureau of Justice Statistics, *Report to the Nation on Crime and Justice*, October 1983, p. 45.

<sup>7</sup>George F. Cole, *The American System of Criminal Justice* (Monterey, California: Books/Cole Publishing Company, 1986) p. 29.

<sup>8</sup>John Kaplan, *Criminal Justice: Introductory Cases and Materials* (Mineola, New York: The Foundation Press, Inc., 1978), p. 89.

<sup>9</sup>Cole, *loc. cit.* p. 30.

<sup>10</sup>"Crime in America," *The Birmingham News*, March 4, 1985, p. 1.

<sup>11</sup>Federal Bureau of Investigation, *Uniform Crime Report--1986*, (Washington, D.C.: U.S. Government Printing Office) p. 63.

<sup>12</sup>Kaplan, *loc. cit.*, p. 611.

<sup>13</sup>James A. Inciardi, *Criminal Justice* (Orlando, Florida: Academic Press, Inc., 1984), p. 143.

<sup>14</sup>R.W. Blaylock, *The Alabama Criminal Justice System*, (Pamphlet), State of Alabama, Criminal Justice Information Center. (Pamphlet)

<sup>15</sup>Larry Wright, *1986 Crime In Alabama*, State of Alabama, Criminal Justice Information Center, pp. 1-171. See also: "Message From The Director" in the same source.

<sup>16</sup>Blaylock, *loc. cit.*

<sup>17</sup>"Downtown crime high on list of concerns," *The Birmingham News*, June 9, 1985, p. 7A.

<sup>18</sup>"Study Finds Fear Of Crime High," *Opelika-Auburn News*, (Opelika-Auburn alabama), March 4, 1985 p. 1.

<sup>19</sup>United States Department of Justice, *Sourcebook of Criminal Justice Statistics--1984*, p. 168.

<sup>20</sup>*Ibid.*

<sup>21</sup>"Many elderly people held prisoner by fear of crime," *The Birmingham News*, May 18, 1986, p. 9A.

<sup>22</sup>Wright, *loc. cit.* p. 16.

<sup>23</sup>*Ibid.*, p. 30.

<sup>24</sup>*Ibid.*, pp. 19, 5.

<sup>25</sup>*Ibid.*, p. 16.

<sup>26</sup>*Ibid.*, p. 20.

<sup>27</sup>"Crime in City," *The Birmingham News*, June 27, 1985, p. 1.

<sup>28</sup>"Crime in America," *The Birmingham News*, March 4, 1985 p. 10A.

<sup>29</sup>"Alabama's Crime Rate Continues Downward Trend," *The Advertiser* (Montgomery), July 12, 1984, p. 1D.

<sup>30</sup>"Public Involvement, tough Alabama law helps cut crime rate," *The Birmingham News*, September 11, 1985, pp. 1, 10A.

<sup>31</sup>*Ibid.* p. 10A.

<sup>32</sup>"Deutchsh credits police and public with third crime-rate cut in row," *The Birmingham News*, April 22, 1985, p. 5A.

<sup>33</sup>"More jobs, community awareness lowered crime rates, police say," *The Journal-Advertiser* (Montgomery), October 28, 1984, p. 15A.

<sup>34</sup>"Deutchsh ties crime increase, city growth," *The Birmingham News*, April 25, 1986, p. 1.

<sup>35</sup>"Experts Differ on FBI Crime Index," *Opelika-Auburn News*, May 12, 1987, p. 2.

<sup>36</sup>*Ibid.*

<sup>37</sup>*Ibid.*

<sup>38</sup>*Ibid.*

<sup>39</sup>*Ibid.*

<sup>40</sup>"Americans face 1-in-133 chance of murder," *The Birmingham News*, May 6, 1985, p. 1.

<sup>41</sup>*Ibid.*

<sup>42</sup>"More to do for victims of crime, group told," *The Birmingham News*, April 18, 1985, p. 7A.

<sup>43</sup>"Judge McAliley Says Society Dominated by Fear of Crimes," *Wiregrass Trader News*, (Enterprise, Alabama), August 14, 1985, p. 9.

<sup>44</sup>"Criminal justice professor's course focuses on victims of criminals," *The Birmingham News*, March 10, 1985, p. 6A.

<sup>45</sup>*Ibid.*

<sup>46</sup>"Ala. puts victim on crime board," *USA Today*, November 30, 1984, p. 3A.

<sup>47</sup>State of Alabama, *Alabama Crime Victims Compensation Act* (1984). In particular, see 15-23-17 (b).

<sup>48</sup>"Year-old agency has proven a boon for crime victims," *The Birmingham News*, November 30, 1985, p. 1.

<sup>49</sup>"Law Allows for Payment to Violate Crime Victims," *The Columbus Enquirer*, September 30, 1985, p. A-3.

<sup>50</sup>*Criminal Justice 81/82*. Annual Editions (Sluice Dock, Guilford, Ct.: Dushkin Publishing Group, Inc., 1981) "Two Hundred Years of Social Economic Change Have Shaped Our Crime Problem," by Bob Eckhart, p. 10. (The article originally appeared in *The Center Magazine*, journal of the Center for Study of Democratic Institutions).

<sup>51</sup>*Ibid.*

<sup>52</sup>*Ibid.*

<sup>53</sup>*Ibid.*

<sup>54</sup>*Ibid.*

ELECTRON-PHONON INTERACTION AND THE LIMITS ON LOWER AND UPPER  
PHONON-WAVE-VECTORS PARTICIPATING IN THE PROCESS

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ABSTRACT

In this paper, an equation for the rate of change of the number of phonons is derived due to electron-phonon interactions, in terms of physically measurable and known quantities. It has been shown that phonons with wave-vector  $\vec{q} < 2\vec{k}_f$  are active in interaction whereas those with  $\vec{q} > 2\vec{k}_f$  remain non-interacting.

INTRODUCTION

A crystal is a periodic arrangement of atoms, each atom consisting of electrons and ions. A lattice vibration makes a momentary shift in the atomic positions of the lattice thereby compressing or expanding it at different points. At these points, the effective periodic potential, the state of electron changes by absorption or emission of a phonon. This results in the scattering of phonons.

In this work, an equation is derived for the rate of change of number of phonons at a given point due to electron-phonon interactions, which can be described in terms of deformation potential constants, phonon velocities, and equilibrium fermi functions. Another equation, and a way to find the minimum and maximum wave-vectors of phonons, that participate in electron-phonon interaction, is also derived and discussed.

THEORY

Due to lattice vibration, the periodic potential  $V(r)$  of the lattice changes by an amount  $\Delta V(r)$  from its value in an undisturbed state. This change in potential is seen by the electrons as a per-

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turbation. The change in potential produced by the displacement  $\vec{u}_\ell$  of the ion at the position  $\vec{\ell}$  is given by

$$\Delta V(\vec{r}) = V[\vec{R} - (\vec{\ell} + \vec{u}_\ell)] - V(\vec{R} - \vec{\ell}) \quad (1)$$

where  $\vec{R}$  and  $\vec{\ell}$  represent the distance of the electron and ion from the origin and  $\vec{r} = \vec{R} - \vec{\ell}$ . To a first approximation it can be regarded as a linear function of the atomic displacement as:

$$\Delta V(\vec{r}) = - \sum_{\ell} \vec{u}_\ell \cdot \text{grad } V(\vec{r}) = \sum_{\ell} \vec{u}_\ell \cdot \nabla_{\ell} V(\vec{r}) \quad (2)$$

The scattering probability for the electron depends on the square of the matrix element between the initial and final states, and on the energy conservation in the process. The lattice states are described by phonon states  $|n_{q\lambda}\rangle$  of wave vector  $\vec{q}$  and polarization  $\lambda$ . The electron is scattered from its previous state with wave vector  $\vec{k}$  to the state with wave vector  $\vec{k}'$ .  $\psi_k$  is the wave function of the electron with wave vector  $\vec{k}$ , after its interaction with phonon. The displacement of ion  $\vec{u}_\ell$  can be expressed in terms of the normal coordinates  $Q_{q\lambda}$  as

$$\vec{u}_\ell = \frac{1}{\sqrt{NV}} \sum_{q\lambda} Q_{q\lambda} \vec{e}_{q\lambda} e^{-i\vec{q}\cdot\vec{\ell}} \quad (3)$$

where  $\vec{e}_{q\lambda}$  is the polarization vector, and  $Q_{q\lambda}$  can be described in terms of phonon annihilation and creation operators. Choosing a particular lattice mode of wave vector  $\vec{q}$  and polarization  $\lambda$ , the matrix element involving the transition of the electron from  $\vec{k}$  to  $\vec{k}'$  is

$$M(\vec{k}, \vec{k}') = \langle n_{q\lambda} | \int \psi_k^*(\vec{r}) \Delta V(\vec{r}) \psi_{k'}(\vec{r}) d\vec{r} | n_{q\lambda} - 1 \rangle \quad (4)$$

In the above transition, a phonon is absorbed as the electron is scattered. Substituting equations (2) and (3) in (4), one gets the following equation.

$$M(\vec{k}, \vec{k}') = -i \sum_{\ell} \left( \frac{\hbar n_{q\lambda}}{2NMV\omega_{q\lambda}} \right)^{1/2} e^{-i\vec{q}\cdot\vec{\ell}} \int \psi_k^*(\vec{r}) [\vec{e}_{q\lambda} \cdot \nabla_{\ell} V(\vec{r}) \psi_{k'}(\vec{r})] d\vec{r} \quad (5)$$

The electron-wave functions satisfy Bloch's theorem (1) under periodically varying potential as:

$$\psi_k(\vec{r} + \vec{\ell}) = e^{i\vec{k} \cdot \vec{\ell}} \psi_k(\vec{r})$$

Hence the matrix  $M(\vec{k}, \vec{k}')$  assumes the following form:

$$M(\vec{k}, \vec{k}') = -i \sum_{\vec{\ell}} \left( \frac{\hbar n_{q\lambda}}{2NMV\omega_{q\lambda}} \right)^{1/2} e^{i(\vec{k}' - \vec{k} - \vec{q}) \cdot \vec{\ell}} \int \psi_k^* \left[ \vec{e}_{q\lambda} \cdot \vec{\nabla}_{\vec{\ell}} V(\vec{r}) \right] \psi_{k'} d\vec{r} \quad (6)$$

and

$$\sum_{\vec{\ell}} e^{i(\vec{k}' - \vec{k} - \vec{q}) \cdot \vec{\ell}} = 0 \quad \text{for } \vec{k}' - \vec{k} - \vec{q} \neq \vec{b}$$

$$= NV \quad \text{for } \vec{k}' - \vec{k} - \vec{q} = \vec{b}$$

where  $\vec{b}$  is the reciprocal lattice vector. The term  $NV$  can be eliminated by taking normalized wave functions.

Thus, matrix  $M(\vec{k}, \vec{k}')$  becomes

$$M(\vec{k}, \vec{k}') = -i \left( \frac{\hbar n_{q\lambda}}{2NMV\omega_{q\lambda}} \right)^{1/2} \delta_{\vec{b}, \vec{k}' - \vec{k} - \vec{q}} I_{q\lambda}(\vec{k}, \vec{k}') \quad (7)$$

where

$$I_{q\lambda}(\vec{k}, \vec{k}') = \int \psi_k^* \left( \vec{e}_{q\lambda} \cdot \vec{\nabla}_{\vec{\ell}} V(\vec{r}) \right) \psi_{k'} d\vec{r} \quad (8)$$

The Kroenecker delta function gives the momentum conservation law for electron-phonon scattering.

The evaluation of  $I_{q\lambda}(\vec{k}, \vec{k}')$  is a complicated process. In order to get an approximate form of  $M(\vec{k}, \vec{k}')$  we use Wigner Seitz method (2), which assumes that the whole potential of the ion is within each cell and zero potential outside. Thus  $I_{q\lambda}(\vec{k}, \vec{k}')$  assumes the form:

$$I_{q\lambda}(\vec{k}, \vec{k}') = \int \psi_k^* \left( \vec{e}_{q\lambda} \cdot \vec{\nabla}_{\vec{\ell}} V(\vec{r}) \right) \psi_{k'} d\vec{r} \quad (9)$$

$$= i \left( V_a - E_0 \right) \vec{e}_{q\lambda} \cdot (\vec{k} - \vec{k}') \int \psi_k^* \psi_{k'} d\vec{r}$$

where  $V_a$  is the potential energy of the electron on the cell boundary and  $E_0$  is the energy of the bottom of the band.

For normal processes, where the momentum is conserved,  $\vec{k}' - \vec{k} = \vec{q}$  and hence  $\vec{e}_{q\lambda} \cdot (\vec{k}' - \vec{k}) = \vec{e}_{q\lambda} \cdot \vec{q}$  is called the polarization factor of the matrix

element. The second factor  $(V_a - E_0)$  is called the energy factor. This factor has been evaluated by Hunter and Nabarro (3) as:

$$(V_a - E_0) = \frac{\delta E_0}{\Delta}$$

where  $E_0$  is the change in the energy of the bottom of conduction band due to dilation produced by the expansion or compression of the

lattice. The term  $\frac{\delta E_0}{\Delta}$  on the right side is usually called the deformation potential,  $E_d$  corresponding to the strain. The third factor  $\int \psi_k \psi_{k'} dr$  is called the overlap integral and for small angles between  $\vec{k}$  and  $\vec{k}'$ ,  $\int \psi_k \psi_{k'} dr = 1$ . Therefore for small angles between  $\vec{k}$  and  $\vec{k}'$ ,

$$I_{q\lambda}(\vec{k}, \vec{k}') = i (\vec{e}_{q\lambda} \cdot \vec{q}) E_\alpha \quad (10)$$

$$\therefore M(\vec{k}, \vec{k}') = \left( \frac{\hbar n_{q\lambda}}{2NVM\omega_{q\lambda}} \right)^{1/2} \delta_{\vec{k}', \vec{k}+\vec{q}} (\vec{e}_{q\lambda} \cdot \vec{q}) E_\alpha$$

The probability of transition between the initial state  $|i\rangle$  with energy  $E_i$  and the final state  $|f\rangle$  with energy  $E_f$  in a time  $t$  is given by time dependent perturbation theory as

$$W = 2 \left| \langle i | H_{ep} | f \rangle \right|^2 \frac{1 - \cos(E_f - E_i)t/\hbar}{(E_f - E_i)^2} \quad (11)$$

The transition probability per unit time is:

$$P_i^f = \frac{2\pi}{\hbar} \left| \langle i | H_{ep} | f \rangle \right|^2 \theta(E_f - E_i) \quad (12)$$

$$\theta(E_f - E_i) = \frac{\sin(E_f - E_i)t/\hbar}{\pi(E_f - E_i)}$$

The transition probability for the process  $\vec{k} + \vec{q} = \vec{k}'$  is:

$$P_{k+q}^{k'} = \frac{2\pi}{\hbar} \left| M(k, k') \right|^2 f_k (1 - f_{k'}) \theta(E_f - E_i) \quad (13)$$

where,  $f_k$  represents the probability that the state  $\vec{k}$  is occupied and  $(1 - f_{k'})$  represents the probability that the final state  $\vec{k}'$  is vacant. Similarly for the reverse process  $\vec{k}' = \vec{k} + \vec{q}$ , the transition probability is given by  $P_{k'}^{k+q}$ . Hence the net rate of change of phonons in the mode  $\vec{q}$  is given by:

$$\frac{\partial n_q}{\partial t} = \sum_{k, k'} \left( p_{\vec{k}'}^{\vec{k}+\vec{q}} - p_{k+q}^{k'} \right) \quad (14)$$

Substituting  $M(\vec{k}, \vec{k}')$  in equation (13) from equation (10), we get

$$p_{\vec{k}'}^{\vec{k}+\vec{q}} = \frac{\pi E_d^2 \eta^2 q}{\rho v \sigma} \left( n_{q\lambda} + 1 \right) f_k (1 - f_k) \theta(E_k, -E_k - \hbar\omega) \delta_{k', k+q} \quad (16)$$

Therefore,

$$\begin{aligned} \frac{\partial n_q}{\partial t} &= \frac{\pi E_d^2 \eta^2}{\rho v \sigma} \sum_{\vec{k}, \vec{k}'} \left[ f_k (1 - f_k) (n_{q\lambda} + 1) - f_k (1 - f_k) n_{q\lambda} \right] \\ &\quad \theta(E_{\vec{k}'} - E_{\vec{k}} - \hbar\omega) \delta_{\vec{k}', \vec{k}+\vec{q}} \end{aligned} \quad (17)$$

We may suppose that the electron distribution is in equilibrium, with  $f_k = f_k^0$ , but  $n_q$  deviates from its equilibrium value. Hence, we get

$$\begin{aligned} &f_k (1 - f_k) (n_{q\lambda} + 1) - f_k (1 - f_k) n_{q\lambda} \\ &= \frac{n_q - n_q^0}{n_q + 1} f_k^0 (1 - f_k^0) \end{aligned} \quad (18)$$

Thus,

$$\begin{aligned} \frac{\partial n_q}{\partial t} &= \frac{\pi E_d^2 \eta^2 q}{\rho v \sigma} (n_q - n_q^0) \sum_{\vec{k}, \vec{k}'} f_k^0 (1 - f_k^0) \\ &\quad \theta(E_{\vec{k}'} - E_{\vec{k}} - \hbar\omega) \delta_{\vec{k}', \vec{k}+\vec{q}} \end{aligned} \quad (19)$$

# RESULTS AND DISCUSSIONS

The equation (19) gives the net rate of change of number of phonons per unit time in terms of physically measurable and known quantities which are available in any standard handbook of Physics and Chemistry (5). This could be further approximated and simplified so that an equation for relaxation rate defining electron-phonon interaction can be developed. In a subsequent paper the relaxation rate equation will be used to calculate the temperature dependence of phonon thermal conductivity of lightly and heavily doped semiconductors.

The theory developed in the previous section will not be complete, without a discussion of the energy and momentum conservation condition. The energy conservation condition gives

$$E_{k'} = E_k + \hbar\omega$$

$$\frac{\hbar^2}{2m^*} (\vec{k} + \vec{q})^2 = \frac{\hbar^2 k^2}{2m^*} + \hbar \vec{q} \cdot \vec{\sigma}$$
(20)

Simplifying the above equation, one gets

$$\left| \frac{\vec{k}}{k} \right| = \left| \frac{m^* \vec{\sigma}}{\hbar} - \frac{\vec{q}}{2} \right| \frac{1}{\cos\theta}$$

where  $\theta$  is the angle between  $\vec{k}$  and  $\vec{q}$ . The minimum value of  $\vec{k}$  is  $\vec{k}_0$ . This is given as

$$\left| \frac{\vec{k}_0}{k_0} \right| = \left| \frac{m^* \vec{\sigma}}{\hbar} - \frac{\vec{q}}{2} \right|$$
(21)

The momentum conservation condition gives

$$\hbar \vec{k}' = \hbar \vec{k} + \hbar \vec{q}$$

The maximum value of phonon wave vector  $\vec{q}$  is  $\vec{q} = 2\vec{k}$ , where  $k_F$  is the electron wave vector at Fermi surface. This suggests that electron-phonon interaction would be significant when  $\vec{q} < 2\vec{k}_F$  and vanishingly small if  $\vec{q} > 2\vec{k}_F$ .

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FACTORS AFFECTING RETAIL GROCERY DEMAND FOR  
SEAFOOD PRODUCTS IN EAST-CENTRAL ALABAMA  
AND WEST-CENTRAL GEORGIA<sup>1</sup>

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INTRODUCTION

Consumption of fish and seafood products has increased in recent years. Since 1967, per capita consumption of fish has increased by 20% (USDA 1984). Production of aquacultural products such as catfish has also increased dramatically. Acreage devoted to commercial catfish production has grown to over 76,000 acres from 400 acres in 1960 (USDA, 1986; Lee, 1981). Yet, market information for catfish and other seafood products is scarce. While most other studies have concentrated on total household food expenditures on seafood products and market channels for catfish (Blaylock and Smallwood, 1986; Cremer *et al.*, 1983; Dixon *et al.*, 1982), little detailed work has been done on specific market outlets for seafood products.

Given the dearth of information on retail seafood marketing, the primary purpose of this study was to identify the most important factors affecting retail grocery demand for different seafood products. A survey was conducted to profile prices and quantities sold of the most important seafood products at the retail grocer level. Although funding was not available for a survey large enough to estimate demand and to evaluate the characteristics and components of demand, the results of this study provide a base-line from which to develop larger-scale research projects. A study done in a limited area, however, has the added benefit of attaining a more comprehensive level of detail than a large regional survey.

Raulerson and Trotter in 1973 analyzed the demand for farm-raised channel catfish in supermarkets by estimating a demand curve and obtaining the resulting price elasticities. The results of a questionnaire

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<sup>1</sup>Manuscript received 16 July 1987; accepted 9 September 1987.

indicated that consumers purchasing catfish tended to be traditional catfish eaters and that fresh fish was preferred.

Studies on market channels for catfish that included retail grocery and supermarket outlets were conducted in Mississippi and Kentucky. Dixon *et al.* (1982) in Mississippi surveyed chain grocery distributors. Their study indicated that most channel catfish were sold whole rather than filleted in supermarkets and that channel catfish sales comprised a small percentage of total seafood sales. In Kentucky, a large majority of retail grocers indicated that their customers preferred fresh fish and would be willing to pay a higher price for fresh fish (Cremer *et al.* 1983). Preferences for filleted products displayed on ice were documented by both these studies as well as Crawford *et al.* (1978) in Alabama. Consumer acceptance interviews of consumers of farm-raised catfish indicated that catfish products were attractive to consumers (Boleware and Dillard, 1984).

These same studies mentioned the need for promotion in the catfish industry. It may be that lack of awareness of the catfish industry and catfish products contributed to its relatively low percentage of total seafood sales. The Catfish Institute in Mississippi has recently commissioned a national promotion campaign designed to increase demand for catfish nationwide. However, there is little information on what promotional efforts are currently being utilized by individual retail outlets.

This paper will present a detailed description of the grocery market for channel catfish as compared to other fish and seafood products. Data on monthly sales, volumes, product form, prices, and observed customer characteristics are presented for all seafood products in grocery stores and supermarkets within the sample area.

## PROCEDURES

A complete listing was made of the 493 grocery or 'convenience' stores (those that used "grocery" in the name of the store) and 136 supermarkets (those that used "supermarket" in their name as well as regional and national chains) in a 13-county area in East-Central Alabama and West-Central Georgia from telephone listings within the past two years. Figure 1 indicates the counties included in the sample area. In order to ensure adequate representation of both supermarkets and groceries, separate samples were drawn at random from each stratum. During the first stage of sampling, outlets were telephoned to check that they sold fish. Those that did not were replaced in order to obtain a final sample of 25 outlets in each category. Ultimately, 125 groceries were contacted, of which 79 did not sell seafood products, 20 were closed, one refused to be interviewed, and 25 were interviewed about their seafood sales (Table 1). Of 33 supermarkets sampled, one did not sell seafood, two had closed, and 30 were interviewed. Of the 30 supermarkets surveyed, 5 were located in rural areas, 15 in suburban areas, and 10 downtown urban locales. Fourteen of the 25 grocery stores were rural, 3 were suburban, and 8 were urban. One-half (50%) of the supermarkets surveyed were regional chains, 37% were independents, and

# Retail Grocery Demand for Seafood Products

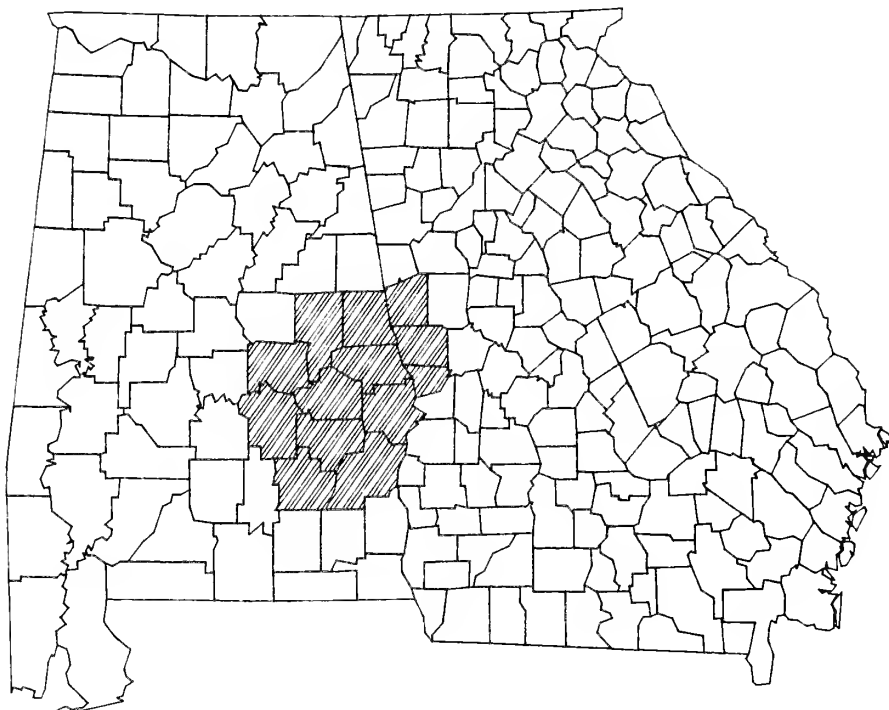


Figure 1. Alabama and Georgia counties included in the study area.

Table 1. Sampling of groceries and supermarkets in East-Central Alabama and West-Central Georgia.

	Groceries	Supermarkets
Sampling universe	493	136
Sample	125	33
No seafood sales	79	1
Store closed	20	2
Refused interview	1	0
Interviewed	25	30

13% were national chain stores. On the other hand, 96% of the grocery stores surveyed were independently owned. Following a one-week pretest, direct personal interviews took place in February and March 1987.

The survey instrument was divided into two parts. The first part elicited general store information including: perceptions on trends in seafood marketing, promotional tactics utilized, desired improvements to increase seafood sales, perceptions of seasonality in consumer demand for seafood, desired changes in supplies, and incidence of purchases from local suppliers. The second part of the questionnaire recorded prices and quantities of fish and seafood sold by level of processing and product conservation. Retail prices were noted from the displayed products at the time of the interview. Survey respondents reported from memory on typical quantities sold, generally based on their normal order period and quantity ordered for each product. Although seafood sales invoice records were requested from the regional headquarters of two chains, these were not made available to the researchers.

Respondents were further asked the origin of their supplies and the age, race, and wealth levels of customers for each seafood product. The pilot test of the survey instrument indicated that the managers were only willing to break age into "young" (under 35) and "old" and wealth into "wealthy" and "poor". Interviews were directed to store employees familiar with seafood sales (in groceries, typically the owner; in supermarkets, the meat and frozen foods managers).

## RESULTS

Supermarkets were more likely to handle seafood than grocery stores. Of the 125 grocery stores contacted, only 20% handled any type of seafood while 94% of the 32 supermarkets did. Supermarkets also handled a greater variety of products (78 different products) than groceries (only 38 different products). Both supermarkets and groceries commonly handled products like catfish, whiting, turbot, red snapper, croaker, mullet, and some oysters and shrimp. Only supermarkets, however, handled haddock, sole, grouper, monk, rainbow trout, shark, amberjack, scallops, mussels, lobster, king crab, or caviar. Two Asian groceries handled Oriental specialty seafood such as walking catfish, snails, eel, and snakehead as well as unidentifiable fish labeled "yellowfish", "wingfish", "hairtail fish", and "scomber fish".

While most of the supermarkets promoted their seafood products, few of the groceries did (Table 2). Two-thirds of the supermarkets used signs either in the store or on the road, newspaper ads, and/or discounted specials. A few supermarkets also used free recipes, separate fish markets in the store, ads over a public address system, presentations in school classrooms, newsletters, taste tests, free samples, or radio advertisement.

Although most grocery stores did not use any promotional strategies, most of those who did commonly put signs either in the store or on the road. A few used newspaper ads, discounted specials or special fish market sections in the stores.

## Retail Grocery Demand for Seafood Products

Table 2. Percentage of outlets employing specific promotional tactics (by outlet type) in retail seafood marketing survey of East-Central Alabama and West-Central Georgia.

Promotional Tactics	Groceries n=25	Supermarkets n=30
	percent	percent
Sign in store/or road	28	63
Advertisements		
Newspaper	4	70
Radio	8	3
Discount special	12	67
Recipes	0	13
Fish market section	4	13
Announcement over P.A. system	0	10
Taste tests	0	7
Other <sup>a</sup>	0	6
No promotion used	72	17

<sup>a</sup>Includes: seafood newsletter and lectures to school children.

Over half of the store managers did not perceive any trends in seafood sales. Similar numbers of store managers perceived falling (15%) as opposed to rising (12%) sales of seafood. Smaller percentages of store managers perceived trends such as; rising prices, greater diversity in sales, lack of fresh fish, and rising sales of catfish, snapper, fillets, and breaded products.

Most of the store managers surveyed were contented with their current supply of seafood products. Greater availability of fresh nile perch, mullet, oysters, salt water fish, snapper, hairtail, and bluetail was desired by some of the surveyed managers. Other expressed a need for greater variety of products, steady supplies, packaged fresh shrimp, a steady supply of shrimp, better quality, and delivery of seafood by wholesalers (Table 3).

Store managers were equally divided on whether demand for seafood was seasonal (44%) or not (46%). While approximately 60% of store managers professed to not knowing if demand was high or low in different seasons, 30% indicated that demand was low in the summer and 22% said that demand was low in the spring. Over 30% indicated that demand was high in the winter and 18% said that demand was high in the fall.

Table 3. Percentages of retail managers that expressed desire for changes in seafood supplies by outlet type in retail seafood marketing survey of East-Central Alabama and West-Central Georgia<sup>a</sup>.

Desired Change	Groceries	Supermarkets
	percent	percent
Greater freshness	0	0
Different products	40	60
Steady supplies	40	19
Better packaging	0	10
Better quality	20	0
Delivery	0	10

<sup>a</sup>Half of all managers interviewed did not express desires for any changes; 25% also indicated a desire for lower prices of seafood supplies. Figures above represent percentages of those managers that desired some change.

Store managers of suburban supermarkets perceived seafood sales as generally increasing and planned to increase counter space, in-store fish markets, and varieties handled. On the other hand, rural grocery store managers anticipated declining sales and generally expected to sell less seafood in the future.

When asked what "improvements" would increase seafood sales, store managers cited: lower prices (21%), availability of fresh fish (19%), more advertisement (12%), greater variety of seafood products (12%), an ice display case (10%), and increased counter space (10%). The need for knowledgeable staff, fish tanks, special fish sales persons, more advertised discounted specials, eliminate fish smells, and a person to dress fish were mentioned less often.

Independent grocers were much more inclined than chain supermarkets to purchase seafood through local suppliers (Table 4). Nearly all of the independent grocers and supermarkets indicated that they use local suppliers. On the other hand, only one-third of the chain supermarket managers used local suppliers.

#### *Monthly Sales*

Shrimp sales, overall, comprised 23% of total monthly dollar sales per store (Table 5). Ocean perch followed with 15% and catfish and whiting each comprised 11% of monthly dollar sales per store.

On a volume basis, however, whiting comprised 27% of the total monthly quantities moved per store. Ocean perch again followed at 14%, shrimp with 13%, catfish with 11% and mullet with 10% of total monthly quantities per store.

## Retail Grocery Demand for Seafood Products

Table 4. Percentages of outlets that buy seafood supplies locally by form of ownership in retail seafood marketing survey of East-Central Alabama and West-Central Georgia.

Outlet	Type of Ownership		
	Chain	Independent	Manager
Groceries	1	24	25
N	0	100	96
%			
Supermarkets			
N	19	11	30
%	37	100	60

Supermarkets moved both greater volumes and greater dollar values for all species. Gross monthly retail sales (in dollars) per store were highest (\$1339) for shrimp (all forms) sold in supermarkets. Ocean perch (\$874/month/store) was second to shrimp sales followed by whiting (\$581/month/store). Monthly catfish sales in supermarkets were half (\$571/store) the dollar value of shrimp.

The dollar value of seafood sales per store in grocery stores was lower than that in supermarkets for each species (Table 5). The highest dollar value of any product in grocery stores was whiting (\$108/month/store). Monthly mullet (\$91/store) catfish (\$81/store), ocean perch (\$58/store), and shrimp sales (\$43/store) were lower.

These same species also clearly predominated in terms of quantities sold. However, whiting sold in the greatest volumes per store in both supermarkets (572 lbs/month) and groceries (137 lbs/month). In supermarkets, ocean perch volumes were the next highest (348 lbs/month/store) followed by shrimp (312 lbs/month/store), and catfish (246 lbs/month/store). Grocery stores, on the other hand, moved almost as much mullet (134 lbs/month/store) as whiting (137 lbs/month/store). More catfish (36 lbs/month) was moved than ocean perch (21 lbs/month) or shrimp (9 lbs/month) per store.

Suburban markets sold more seafood products (\$7064/month/store) than urban (\$1889/month/store) or rural (\$889/month/store) (Table 6). Both suburban supermarkets and grocery stores sold more seafood than rural or urban supermarkets or grocery stores.

### *Product Form and Prices*

Differences were found in form of product conservation of different species. Catfish were primarily sold fresh (84%) with only 16% of cat-

Table 5. Monthly retail sales and quantities sold per supermarket and grocery store by major species.

Species	Sales				Quantities			
	Supermarkets	Groceries	Total		Supermarkets	Groceries	Total	
	\$	% of total	\$	% of total	\$	% of total	lbs. total	% of total
Catfish	571	11	81	12	652	11	246	12
Flounder	235	4	9	1	244	4	58	3
Mullet	154	3	91	14	245	7	145	7
Ocean perch	874	16	58	9	932	15	348	16
Oyster	264	5	16	2	280	5	51	2
Red Snapper	134	2	14	2	148	2	34	2
Shrimp <sup>a</sup>	1339	25	43	7	1382	23	312	15
Whiting	581	11	108	17	689	11	572	27
Other seafood <sup>b</sup>	1270	23	230	35	1500	25	364	17
All seafood	5422	100	650	100	6072	100	2130	100

<sup>a</sup> All sizes<sup>b</sup> See Appendix A



# Retail Grocery Demand for Seafood Products

fish products handled frozen (Table 7); mullet is likewise a predominantly fresh (80%) product. On the other hand, 82% of ocean perch and 93% of whiting were sold frozen.

Table 6. Mean monthly seafood sales per supermarket and grocery store by locale.

Locale	Supermarket			Grocery Store			All outlets		
	n	\$	lbs	n	\$	lbs	n	\$	lbs
Rural	5	2117	1196	14	451	434	19	889	635
Suburban	15	8103	2750	3	1866	917	18	7064	2444
Urban	10	3108	1709	8	365	296	18	1889	1081

Table 7. Percentage frequency of products by freshness and level of processing.

Product	Fresh			Frozen			All	
	Dressed <sup>a</sup>	Fillet	Other <sup>b</sup>	Dressed <sup>a</sup>	Fillet	Other <sup>b</sup>	Fresh	Frozen
	%	%	%	%	%	%	%	%
Catfish	76	24	0	43	29	28	84	16
Whiting	50	50	0	75	16	9	7	93
Ocean perch	25	75	0	0	100	0	18	82
Mullet	55	0	45 <sup>c</sup>	20	0	80 <sup>c</sup>	80	20

<sup>a</sup>"Dressed" is dressed and headless

<sup>b</sup>"Other" includes whole fish and "nuggets"

<sup>c</sup>"whole", undressed fish with heads

Most of the fresh catfish sold were dressed (76%), i.e., skinned, gutted, and headless. Over half (55%) of the fresh mullet sold was also dressed, but 45% was sold as a whole, undressed product. Eighty percent of frozen mullet sold was in the form of a whole fish. Frozen whiting was generally (75%) sold dressed, but fresh whiting was sold equally often as a fillet or dressed. Ocean perch was sold as a fillet 100% of the time in frozen form and 75% of the time for fresh products.

Dressed fish, whether fresh or frozen, had less variation in price than fresh and frozen fillets (Table 8). For example, fresh, dressed whiting had a price range of \$0.99-\$1.19, whereas fresh fillets varied in price from \$1.19-\$3.99. Whiting and mullet were generally priced lower than other fish products. Fresh, dressed catfish and ocean perch

average prices were comparable, \$2.25 and \$1.96/lb., respectively, although fresh catfish was more widely available.

Table 8. Average prices and price range for major products by species and product form.

Species	Product Form	n	Average Price	Price Range
			\$/lb	\$/lb
Catfish				
Fresh	dressed	28	2.25	1.49 - 2.79
	fillet	8	3.04	1.99 - 3.69
Frozen	dressed	3	2.52	2.39 - 2.59
	fillet	2	3.39	2.99 - 3.79
Flounder				
Fresh	dressed	1	2.99	2.99 - 2.99
	fillet	7	4.20	1.99 - 7.99
Frozen	fillet	19	3.58	1.99 - 4.79
IQF	fillet	1	5.85	5.85 - 5.85
Mullet				
Fresh	whole	8	0.99	0.59 - 1.69
	dressed	10	1.40	1.07 - 1.49
Frozen	whole	4	0.76	0.58 - 1.29
	dressed	1	1.39	1.39 - 1.39
Salted	dressed	3	1.09	0.99 - 1.29
	fillet	2	0.97	0.95 - 0.99
	steaks	1	0.59	0.59 - 0.59
Ocean Perch				
Fresh	dressed	3	1.96	1.89 - 1.99
	fillet	9	3.49	2.29 - 4.99
Frozen	fillet	54	2.65	1.00 - 4.52
Whiting				
Fresh	dressed	2	1.09	0.99 - 1.19
	fillet	2	2.59	1.19 - 3.99
Frozen	whole	5	0.97	0.79 - 1.33
	dressed	43	1.03	0.59 - 4.99
	fillet	9	1.83	0.99 - 3.99

## Retail Grocery Demand for Seafood Products

Although most of the surveyed seafood was sold fresh or frozen, some was also "individually-quick-frozen" (IQF) or salted. The percentage of seafood products reported as IQF probably underestimate the actual amount, since some respondents referred to IQF products as "frozen". IQF fish found included: turbot, red snapper, cod, ocean perch, flounder, and grouper. Of these, ocean perch was most often packaged IQF. The 4% of fish products that were salted included: mullet, cod, mackerel, and herring.

Shrimp prices varied primarily by size. Shrimp sizes are measured according to the number of shrimp per pound, so 26-30 count shrimp require that many individual shrimp to make a pound. Jumbo shrimp (16-20 count, or 16-20 shrimp per pound) were the most expensive (\$7.99-10.65 per pound) with 60-70 count shrimp being the least expensive (\$2.99-\$3.99 per pound) (Table 9). A large percentage (40%), however, was sold as "frozen peeled" without specifying the size of the shrimp. Prices for this group ranged more widely than for all other size groups (\$2.59-\$10.65), with a mean of \$5.46/lb.

Table 9. Average price and price range (1987) of shrimp by size<sup>a</sup>.

Size	Frequency of Product Occurrence	Average Price	Price Range
No. per pound	%	\$/lb	\$/lb
16 - 20	19	9.96	7.99 - 10.65
26 - 30	6	6.35	4.69 - 8.00
36 - 42	11	5.86	4.99 - 6.99
50 - 60	13	4.64	2.99 - 6.99
60 - 70	4	3.49	2.99 - 3.99
Butterfly	2	5.46	5.46 - 5.46
Unspecified size <sup>b</sup>	40	5.46	2.59 - 10.65

<sup>a</sup>Sizes listed are those found in the sampled stores. Some sizes like 21-25, 31-35, etc., were not observed in any of the stores studied.

<sup>b</sup>Labeled "frozen peeled" in stores.

Most shrimp were sold frozen (42%) or IQF (23%) (Table 10). Of these, 85% of the frozen shrimp and all of the IQF shrimp were sold peeled. Fresh shrimp, on the other hand, were mostly sold unpeeled with the heads off (76%). Only one store handled heads-on shrimp.

### *Observed Customer Characteristics*

Knowledge of customer characteristics is essential in interpreting the demand for different products. Retail managers were asked to describe typical ages, incomes, and race of customers who purchased different species.

Table 10. Frequency and percent of peeled and unpeeled shrimp by product form.

Product Form	Level of Processing						Total	
	Unpeeled				Peeled			
	heads on		heads off		heads off			
	no.	%	no.	%	no.	%	no.	%
Fresh	1	6	13	76	3	18	17	35
Frozen	-	-	3	15	17	85	20	42
IQF	-	-	-	-	11	100	11	23

Of the responses obtained, 71% indicated that people over 35 years of age are the primary purchasers of catfish and 92% said the same for whiting (Table 11). Two-thirds of the managers indicated that young people (under 35) buy more shrimp than older people. Both younger (48%) and older (52%) people were perceived to be purchasers of ocean perch.

Table 11. Retailers' perceptions of fish and seafood customer characteristics by species<sup>a</sup>.

Species	Age		Income		Race	
	Over 35	Under 35	Wealthy	Poor	White	Black
	%	%	%	%	%	%
Catfish	71	29	56	44	51	49
Whiting	92	8	6	94	10	90
Ocean Perch	52	48	19	81	44	56
Shrimp <sup>b</sup>	33 1/3	66 2/3	82	18	83	17

<sup>a</sup>The percentages indicate the frequency of responses by retailers of the observed characteristics of customers of different species.

<sup>b</sup>All sizes.

Retailers perceived both wealthy (56%) and poor people (44%) to purchase catfish. Whiting and ocean perch, however, were viewed as products bought by poor people by 94% and 81% of respondents, respectively. Shrimp was perceived as a higher-income product (82%).

Retailers observed both whites and blacks to buy catfish (51% and 49%, respectively) and ocean perch (44% and 56%, respectively). However, whiting was perceived as a black customer's product (90%) whereas shrimp was most often perceived as a white person's product (83%).

## Retail Grocery Demand for Seafood Products

### DISCUSSION AND CONCLUSIONS

The most important factors affecting retail grocery demand for seafood products as determined by this study included; type and location of grocery outlet, species sold, and consumer tastes and preferences. Promotional efforts at the individual grocer level are not significant at the present time.

Supermarkets handled the bulk of seafood sales. This finding is likely indicative more of a trend in overall grocery shopping than it is a trend specific to seafood marketing. Indeed, many grocery stores listed in the telephone book had gone out of business by the time interviews were scheduled. Many grocery stores in this study also seemed to be moving away from the grocery business into convenience products like soda and chips.

Rural grocery stores tended to offer less variety and generally handled frozen whiting and perch as well as occasional salted fish. Urban and suburban supermarkets with middle-class clienteles sold large volumes and offered a wider variety of fresh and frozen seafood products. Managers in this market segment expected increasing future sales and planned to expand their seafood marketing efforts. It can be inferred that, in the zone surveyed, the reported increase in per capita seafood consumption nationwide is probably concentrated in higher-income urban and suburban markets.

The most important seafood products in terms of greatest volumes and gross retail sales were: catfish, ocean perch, whiting, and shrimp. Unlike the Mississippi study, conducted seven years previously, catfish was not an insignificant product, but neither was it the most important. It accounted for 11% of both dollar sales and volumes moved. In terms of dollar sales, it ranked third along with whiting while in terms of volume, it ranked fourth (with mullet). Catfish was the most widely handled fresh fish product whereas whiting was the most commonly purchased frozen product.

A number of store managers (10%) expressed a need for greater availability of fresh fish. During the study, observations were made of cases where fish sold fresh had been purchased frozen. In other cases, fresh fish products on ice that were not sold after a few days were frozen (Cremer *et al.*, reported similar observations from Kentucky). There appears to be great variability in the quality of seafood products marketed.

In several European countries, notably Italy and Belgium, fish products sold in restaurants, supermarkets, and fish markets, must be labeled to indicate whether the products were fresh or frozen upon arrival at the particular market (Vincke 1987). Dates of original packaging must also be clearly indicated. Given the increased demand for quality fish and seafood products in the United States, it would seem that efforts to standardize product quality would be of increasing importance.

The limited funding for this study did not permit customer interviews to obtain comprehensive data on consumer demographics. The retail managers interviewed, however, were asked to categorize their customers by race, age and perceived income level. These perceptions may be biased, particularly in large stores with large clienteles. However, managers base their purchase of products on perceptions of the tastes and preferences of that store's particular clientele. Comprehensive national and regional household surveys are necessary to develop accurate profiles of seafood consumers.

Catfish were perceived by store managers to be primarily purchased by older people, regardless of income or race. Whiting was primarily perceived as a product bought by older, black, and poor people. Ocean perch was primarily purchased by poor people, regardless of age or race. Younger, wealthier, white people were judged by respondents to be the primary purchasers of shrimp.

Seafood sales are spread among a variety of different products all of which appear to be good substitutes. Consumers appear to be segmented more along lines of price and form of fish products. As indicated in the Kentucky study, this study indicated that a high-quality, fresh fish product appears to be the most desirable seafood product. Returns to promotion of a standardized, uniformly high-quality fresh product should be high. The recent promotional campaign for catfish has not focused on freshness and quality as major themes.

Although the proportion of the market currently held by aquaculture products is small, potential seems to be high. Rising prices, general acceptance of catfish, and changing consumer tastes and preferences indicate that promotional efforts to increase consumers' awareness of aquacultural products would yield high returns.

Additional market research of seafood products is needed. Larger, regional studies would permit estimation of demand for different seafood products. Income elasticities of demand for the five major species would be useful in designing promotional strategies. Cross elasticities of demand would further determine quantitatively the degree of substitutability between different seafood products. In particular, returns to promotion of particular attributes such as freshness and standardized quality should be estimated.

Appendix A  
Monthly Gross Retail Sales and Quantities Sold  
Per Store by Species

Species	Sales	Quantities
	\$	lb
Butterfish	3	1
Catfish	348	151

# Retail Grocery Demand for Seafood Products

Cod (Scrod)	33	7
Croaker	48	27
Flounder	133	33
Grouper	47	10
Haddock	15	4
Halibut	19	3
Herring	5	2
Imitation crab meat	67	17
King crab	36	4
Lobster	27	2
Mackerel	7	3
Mahi-Mahi	4	2
Monk	8	2
Mullet	125	140
Mussels	4	3
Ocean catfish	---	4
Ocean perch	503	199
Octopus	18	12
Orange roughy	24	4
Oysters	152	30
Pan trout	4	2
Pollock	10	4
Rainbow trout	16	5
Red snapper	79	20
Salmon	37	6
Scallops	33	5
Sea trout	---	30
Shark	10	2
Sheepshead	3	2
Shrimp	750	174
Smelt	2	1
Snow crab	29	7
Sole	12	3
Squid	18	12
Swordfish	33	5
Tilapia/Nile perch	33	23

Tuna	17	2
Turbot	13	4
Whiting	366	374

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LACTATE DEHYDROGENASE ACTIVITY IN BENZOYL PEROXIDE  
INDUCED PLATELET AGGREGATION<sup>1</sup>

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INTRODUCTION

Benzoyl peroxide (BPO) is used in industry and medicine. Industrially, BPO is used for the manufacturing of plastics. As a bleaching reagent, it is incorporated into substances such as flour, as a commercial preparation at a concentration of approximately 15 parts per million. In dentistry, BPO is used as a component of resin cements. It is an effective and widely used agent in the topical treatment of inflammatory acne (Anderson et al. 1975), decubitus (bed sores) and other cutaneous ulcers (Pace 1976), and pyoderma gangrenosum (Nguyen 1977).

Our previous studies have shown that benzoyl peroxide induces human platelet aggregation in a dose-dependent manner. At a benzoyl peroxide concentration of 0.6mM the aggregation was biphasic, a phenomenon also observed when aggregation was induced by epinephrine and ADP. Indomethacin was not an effective inhibitor of this aggregation. However, vitamin E was a potent inhibitor of benzoyl peroxide-induced aggregation (Gwebu et al. 1983).

The purpose of the present study was to determine whether benzoyl peroxide induces platelet aggregation by indiscriminate platelet lysis or by the normal process of platelet activation. If platelet lysis occurs during benzoyl peroxide-induced aggregation, then the LDH activity should be elevated in the plasma following aggregation. It is well known that ADP-induced platelet aggregation does not involve platelet lysis as determined by lack of LDH elevation (Evans 1985). Peake et al. (1984) have reported that when platelet lysis is prevented, platelet-poor plasma and serum show essentially the same LDH activity.

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# MATERIALS AND METHODS

## *Preparation of Platelet Rich Plasma (PRP)*

Blood was collected from healthy human volunteers who had not ingested aspirin or aspirin-like substances for at least two weeks. Nine volumes of blood were combined with one volume of 3.8% sodium citrate solution in a plastic centrifuge tube. The mixture was centrifuged for 10 minutes at 1150 rpm. After removal of the PRP, the remaining contents were centrifuged for 15 minutes at 2000 rpm to obtain platelet poor plasma (PPP). The PPP was used as reference for 100% light transmission on the aggregometer.

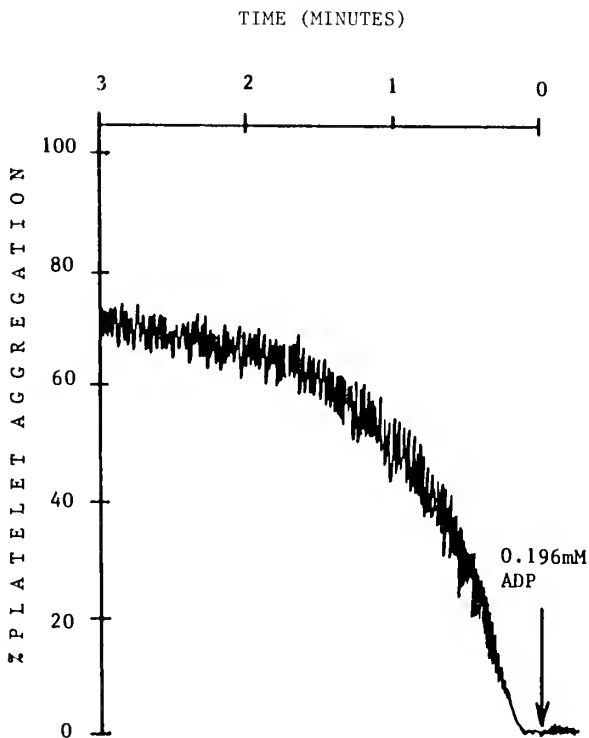


Figure 1. ADP - Induced human platelet aggregation measured as percent. Ten microliters of ADP was added to 500 microliters of platelet-rich plasma and aggregation was monitored for three minutes.

## Lactate Dehydrogenase Activity

### *Platelet Aggregation*

Crystalline benzoyl peroxide (BPO, Aldrich Chemical Company, Milwaukee, WI) was dissolved in methanol and used to induce aggregation. Platelet aggregation was induced by 0.98mM BPO and measured for 3 minutes on an aggregometer (Chrono-Log Corporation, Havertown, PA) as previously described (Gwebu et al. 1983). The contents of the cuvettes were transferred to a plastic centrifuge tube. The process was repeated with 0.196mM Adenosine 5'-diphosphate (ADP) as the aggregating agent. In addition, a sample of PRP was freeze-thawed five times to lyse the platelets. The three tubes containing BPO-treated, ADP-treated, and freeze-thawed aliquots, respectively, were then centrifuged at 3000 rpm for 15 minutes to obtain platelet free plasma (PFP). The supernatants (PFP) were used to assay for lactate dehydrogenase (LDH) activity.

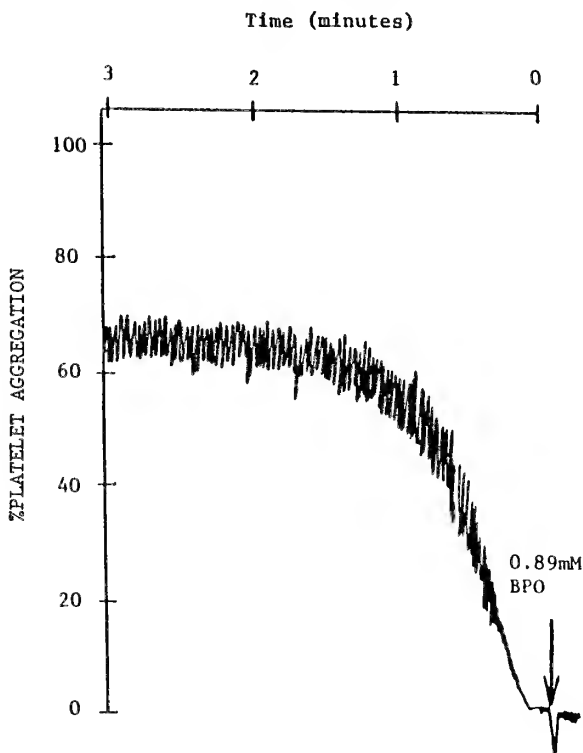


Figure 2. Benzoyl Peroxide - Induced human platelet aggregation measured as percent. Ten microliters of benzoyl peroxide was added to 500 microliters of platelet-rich plasma and aggregation was monitored for 3 minutes.

*Lactate Dehydrogenase Assay*

The lactate dehydrogenase was assayed according to the Sigma Colorimetric LDH Procedure [kit#500] (Sigma Diagnostics, St. Louis, MO). This procedure recommends the use of serum, however, in our study platelet-free plasma was used in place of serum. Platelet-free plasma was preferred over platelet-poor plasma to totally exclude platelets in the samples. Platelets in plasma have been shown to interfere with the LDH assay (Peake et al. 1984).

## RESULTS AND DISCUSSION

Platelet aggregation induced by ADP and benzoyl peroxide is illustrated in Figures 1 and 2, respectively. The LDH standard curve is shown in Figure 3. The LDH activity in the platelet free plasma of ADP-treated, benzoyl peroxide treated and freeze-thawed platelet rich plasma samples was determined using this standard curve. The results are shown in Table 1. The freeze-thawed (lysed) platelets are expected to have maximum LDH activity.

The lactate dehydrogenase activity in the freeze-thawed platelet-free plasma was nineteen times the activity in the benzoyl peroxide-treated platelet-free plasma. The enzyme activity in ADP-treated platelet-free plasma was our control. It is evident from these data that benzoyl peroxide-induced platelet aggregation does not involve platelet lysis.

Studies are underway to elucidate the mode of action of benzoyl peroxide on platelet function.

Table 1. Lactate Dehydrogenase Activity based on spectrophotometric analysis.

Platelet-Free Plasma	Spectrophotometric Absorbance at 495 nm			Total LDH Enzyme Activity (B-Bunits)
Freeze-thawed PRP (7 samples)	0.06	±	0.10 (SD)	$1.9 \times 10^3$
ADP-treated PRP (6 samples)	0.78	±	0.10 (SD)	$1.4 \times 10^2$
BPO-treated PRP (6 samples)	0.81	±	0.12 (SD)	$1.0 \times 10^2$

\* B-B is Berger-Broida units (Sigma)

1 B-B unit x 0.48 = 1 International Unit

# Lactate Dehydrogenase Activity

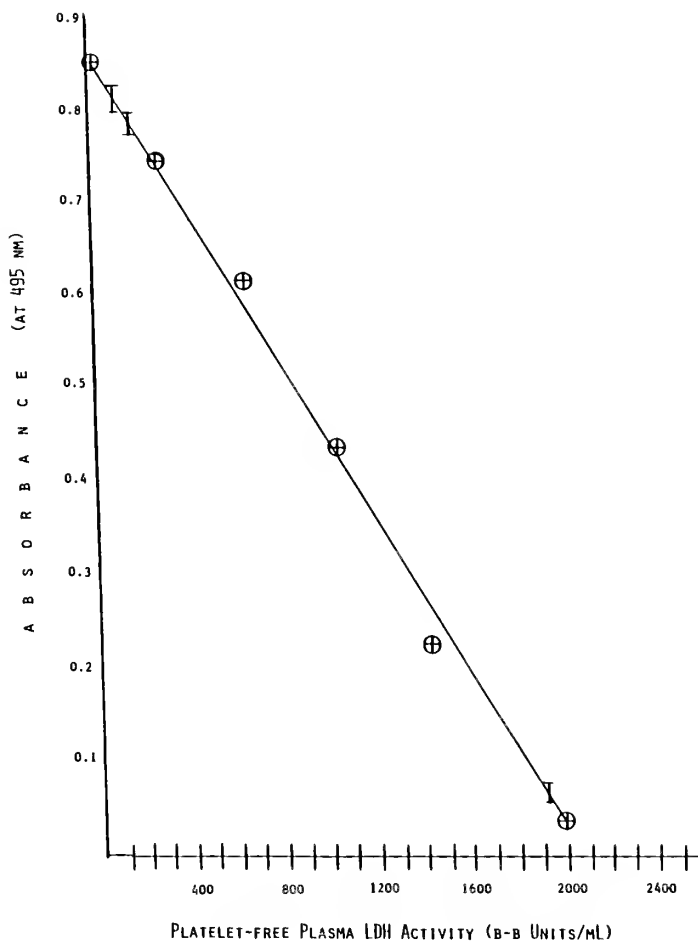


Figure 3. Calibration curve for platelet-free plasma LDH. One international unit (U) of an enzyme is defined as that amount of enzyme that will convert 1 $\mu$ mol of substrate per minute under the specified conditions of the procedure. The conventional units of LDH as used in the described procedure may be converted to U by multiplying by 0.48.

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EFFECT OF DDT ON HUMAN BLOOD PLATELET AGGREGATION<sup>1,2</sup>

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INTRODUCTION

A problem of immediate concern is the effect of DDT (dichlorodiphenyl trichloroethane) on the health of Triana residents in North Alabama. These residents have been drinking water and eating fish from local rivers contaminated with DDT for over 35 years. In 1980, the Centers for Disease Control in Atlanta reported an average serum DDT level 4 times higher than normal in 12 Triana residents. This report prompted us to examine the effect of DDT on platelet aggregation *in vitro*.

Platelet aggregation is the adherence of one platelet to another. Aggregation of human blood platelets is the first hemostatic response to vascular injury. It can be induced by adding aggregating agents to platelet rich plasma, *in vitro*. Platelet aggregation is a very sensitive physiological phenomenon, influenced by various drugs and many other substances (Kangasaho et al., 1983). Human blood platelets thus provide a useful experimental tool to investigate the potential harmful effects of xenobiotic materials such as DDT.

MATERIALS AND METHODS

*Preparation of DDT-Treated Blood and Platelet-Rich Plasma*

Blood was collected from non-Triana, healthy human volunteers who had not taken drugs known to interfere with platelet function for at least three weeks. Nine volumes of blood were mixed with one volume of 3.8% sodium citrate anticoagulant. The blood was divided into two parts. To one part was added DDT (dissolved in methanol) to give a concentration of 0.17mM. The other part was mixed with methanol and used as control blood. The samples were left standing at ambient temperature for 2.5 hours with mixing at regular intervals (Figure 1). After 2.5 hours, platelet-rich plasma (PRP) was prepared according to the procedure of Panganamala et al. (1977).

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<sup>1</sup>Manuscript received 25 May 1987; accepted 8 December 1987.

<sup>2</sup>Presented in parts at the 65th Annual Meeting of the Federation of the American Societies for Experimental Biology, April 1981.

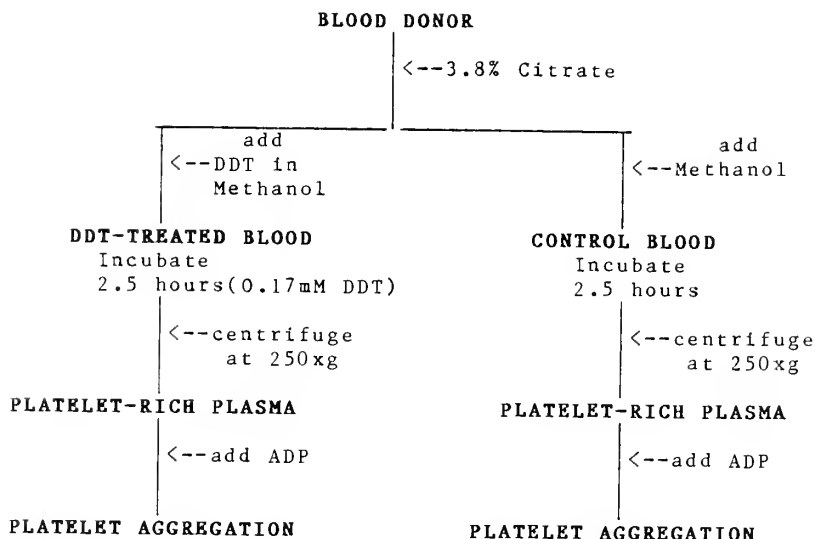


Figure 1. Flowchart for preparation of test and control samples.

### *Platelet Aggregation*

Adenosine diphosphate (ADP) (0.2mM) was used to induce platelet aggregation. Ten microliter aliquots of ADP were added to 0.5ml of PRP from either DDT-treated blood or methanol-treated blood (control). Platelet aggregation was measured with an aggregometer (Chrono-Log Corp., Havertown PA) while the PRP was maintained at 37° and stirred at 1200 rpm throughout the aggregation experiment. Platelet aggregation was monitored for 3 minutes.

### RESULTS AND DISCUSSION

The effect of pre-incubating blood with DDT on platelet aggregation was studied. Platelet aggregation in PRP prepared from DDT-treated blood was induced by adding ADP (0.2mM) and measured with an aggregometer for 3 minutes. This aggregation was  $25 \pm 4\%$  (6 volunteers) compared with platelet aggregation in control blood of  $68 \pm 2\%$  (6 volunteers), showing that DDT impairs human platelet aggregation. Figure 2 shows the typical contrasts in platelet aggregation between control blood platelets and DDT-treated blood platelets. We conclude that when human blood is exposed to 0.17mM DDT for 2.5 hours, ADP-induced platelet aggregation is inhibited. However, when PRP from blood not treated with DDT was preincubated with DDT for 10 minutes prior to adding ADP, platelet aggregation was not inhibited. Krug et al. (1985) have also reported that when PRP is exposed to DDT for 10 minutes, there



## DDT and Human Blood Platelet Aggregation

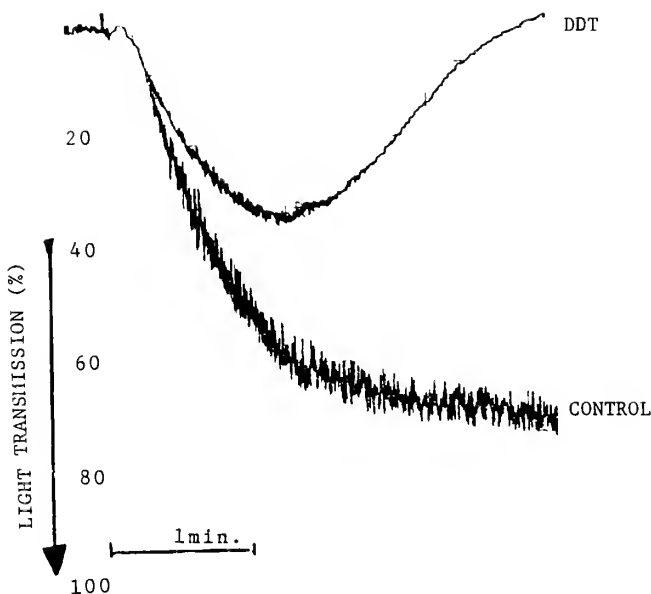


Figure 2. Aggregation pattern for platelets from DDT-treated blood compared with control. The blood was pre-incubated with 0.17mM DDT for 2½ hours prior to preparation of platelet-rich plasma. Aggregation was started with 0.2mM ADP.

was no inhibition of platelet aggregation. Platelets lose potency if left in PRP for an extended period, therefore we did not incubate PRP with DDT for 2.5 hours. When PRP was pre-incubated with DDE (Dichlorodiphenylethylene) for 10 minutes, platelet aggregation was strongly inhibited (Krug et al., 1985). It is possible that blood platelets convert DDT to DDE during a 2.5 hour incubation period at ambient temperature. Therefore, the observed inhibition of platelet aggregation in DDT-treated blood may be due to DDE.

Studies are underway to determine (a) whether platelets in PRP or in whole blood metabolize DDT to DDE, and (b) the mechanism of DDT inhibition of platelet aggregation.

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RELATIONSHIP BETWEEN THE CLASS ATTENDANCE  
AND THE FINAL COURSE GRADES<sup>1</sup>

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ABSTRACT

A study was conducted to see if a relationship existed between the class attendance and the assigned final course grades for students taking various Mathematics and Computer Science courses at Tuskegee University. The results revealed that (1) approximately 88% (50 out of 57) of the students who missed more than 15 lecture days (approximately 30%) achieved an unsatisfactory final course grade (D or an E [failure] grade); and (2) there is enough statistical evidence to believe that if the number of days absent is low, the final course grade achieved is significantly better. The number of days absent and the final course grade achieved were found to be negatively correlated.

INTRODUCTION

An earlier study has shown that there was a relationship between the scores on the first test and the final course grades for students taking Elementary Algebra (Math 105) at Tuskegee University (Misra, et al., 1987). The results in that study revealed that approximately 76% of the students who achieved an unsatisfactory grade (D or E) on the first test also received an unsatisfactory grade for the semester. Unsatisfactory grades for these students were also achieved in subsequent tests and on the final examination. Reviews of this paper by referees when the paper was submitted for publication were encouraging and supportive of subsequent research related to this topic. One referee stated that "one thing that this paper may do (and has done in my department) is to get some teachers to talk about this possible first test syndrome" (Anonymous, 1987). The present paper reports on a study designed to determine if a relationship exists between class attendance and final course grade.

METHODS

Data for the academic year 1985-86 were obtained from two instructors (Bales and Misra) who kept an accurate record of the attendance in the eight courses they taught during the academic year. The courses included Elementary Algebra, Introductory Computer Science, Calculus, and some advanced level courses. Only the data from students who completed the courses (did not drop the course or withdraw) were analyzed using cross-tabulation and correlation analyses between number of days absent and final course grade to determine if a trend existed.

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<sup>1</sup>Manuscript received 17 December 1986; accepted 19 February 1987.

## RESULTS

Data on a total of 367 students were available for this study. Of the total number of students who completed the course, 209 passed with a C or better grade (satisfactory), and 158 achieved D or the failing E grade (60 earned D and 98 earned E). Students who earn the grade of E must repeat the course, as do many students who are assigned a D. Unsatisfactory grades in this paper mean a grade of D or E.

A cross-tabulation of the final course grade versus number of days absent is given in Tables 1 and 2. Table 1 classifies the number of days absent into four categories; low corresponding to 0 to 4 days absent, medium low corresponding to 5 to 9 days absent, medium high corresponding to 10 to 14 days absent, and high corresponding to 15 or more days absent.

Table 1. Cross Tabulation of the Final Course Grades Versus Number of Days Absent.

Number of Days Absent	Final Course Grades					Total
Categories	A	B	C	D	E	
0 to 4 (Low)	40	43	50	23	8	164
%	24.4	26.2	30.5	14.0	4.9	44.7
5 to 9 (Med Low)	8	18	26	19	24	95
%	8.4	18.9	27.4	20.0	25.3	25.9
10 to 14 (Med High)	5	4	8	12	22	51
%	9.8	7.9	15.7	23.5	43.1	13.9
15 or more (High)	1	1	5	6	44	57
%	1.7	1.8	8.8	10.5	77.2	15.5
Total	54	66	89	60	98	367
%	14.7	18.0	24.3	16.3	26.7	100.0

Table 2 further condenses these categories into three; low corresponding to 0 to 4 days absent, medium corresponding to 5 to 15 days absent, and high corresponding to 15 or more days absent. This was done for more robust statistical analysis. In this condensed Table 2, the expected cell frequencies for any cell were not less than 5. The calculated Chi-square value of 133.97 with 8 degrees of freedom was found to be highly significant. Both the contingency coefficient of 0.52 and Pearson's correlation coefficient R of -0.54 were found to be highly significant. Thus, there is enough statistical evidence to believe that if the number of days absent is low, the final course grade achieved is significantly better. The conclusions are summarized below:

- \* Approximately 88% (50 out of 57) of the students who missed 15 or more lecture days achieved an unsatisfactory final course grade.

## Class Attendance and Final Course Grade

- \* Approximately 67% (34 out of 51) of the students who missed 10 to 14 lecture days achieved an unsatisfactory final course grade.
- \* Approximately 45% (43 out of 95) of the students who missed 5 to 9 lecture days achieved an unsatisfactory final course grade.
- \* Approximately 19% (31 out of 164) of the students who missed 0 to 4 lecture days achieved an unsatisfactory final grade.
- \* The percentage of students who achieved an unsatisfactory grade increased with increasing number of days absent.
- \* Students who continuously remained absent (except exam days) did not take advantage of dropping the course.
- \* There is enough statistical evidence to believe that if the number of days absent is low, the final course grade achieved is significantly better. The number of days absent and the final course grade achieved are negatively correlated.

Table 2. Cross Tabulation of the Final Course Grades Versus  
Number of Days Absent.

Number of Days Absent	Final Course Grades					Total
	A	B	C	D	E	
<u>Categories</u>						
0 to 4 (Low)	40	43	50	23	8	164
%	24.4	26.2	30.5	14.0	4.9	44.7
5 to 15 (Medium)	13	23	34	32	48	150
%	8.7	15.3	22.7	21.3	32.0	40.9
15 to more (High)	1	0	5	5	42	53
%	1.9	0.0	9.4	9.4	79.3	14.4
Total	54	66	89	60	98	367
%	14.7	18.0	24.3	16.3	26.7	100.0

### ACKNOWLEDGEMENTS

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## Notes

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SPAWNING IN THE BANDFIN SHINER, *NOTROPIS ZONISTIUS*  
(PISCES: CYPRINIDAE)<sup>1</sup>

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ABSTRACT

Aggregations of the bandfin shiner, *Notropis zonistius*, were observed spawning over the nests of *Campostoma pauciradii* and *Nocomis leptcephalus* in two small streams in the Chattahoochee River drainage. Nest associations of this type have been reported for several other species of cyprinids, including close relatives of *N. zonistius*. At this time it is not known whether nest association in this species is obligatory or facultative. If nest association is facultative, it could be that the associates are merely taking advantage of the clean gravel substrate made available by the nest builders.

*Notropis zonistius* is an inhabitant of small to medium-sized clear streams and is largely restricted in distribution to the Chattahoochee River drainage. It is a member of the subgenus *Luxilus*, which also includes *Notropis albeolus*, *N. cerasinus*, *N. chrysocephalus*, *N. cornutus*, *N. coccogenis*, *N. pilsbri*, and *N. zonatus*. Very little is known about the spawning habits of most members of the genus *Notropis*. Many of the published accounts of spawning in this genus deal with nest association.

Nest association, defined as spawning on the nest of another species, has been reported in three subgenera of *Notropis*: *Lythurus*, *Hydrophlox*, and *Luxilus*. In the subgenus *Lythurus*, *N. ardens* has been reported to spawn over *Nocomis* nests (Raney, 1947), and *N. umbratilis* was found to use the nests of green sunfish, *Lepomis cyanellus*, (Hunter and Hasler, 1965) and longear sunfish, *Lepomis megalotis* (Smith, 1979). Members of the subgenus *Hydrophlox* that have been observed spawning over the nests of *Nocomis* include *Notropis rubellus* (Raney, 1947), *N. rubricroceus* (Outten, 1958), *N. lutipinnis* (McAuliffe and Bennett, 1981; Maurakis and Kahnke, 1987), *N. leuciodus* (W. Roston, pers. com.), and *N. chlorocephalus* (Johnston, pers. obs.). Species of the subgenus *Luxilus* known to use *Nocomis* or *Campostoma* nests are *N. cornutus* and *N. chrysocephalus* (Raney, 1940); *N. cerasinus* (Raney, 1947), *N. zonatus* (Pflieger, 1975), and *N. coccogenis* (Outten, 1957).

<sup>1</sup>Manuscript received 9 November 1987; accepted 18 December 1987.

## Spawning in the Bandfin Shiner

During mid-afternoon on 21 April 1985, a spawning aggregation of 20-30 *Notropis zonistius* was observed over a nest of *Camptostoma pauciradii* in a tributary to Halawakee Creek (Chattahoochee drainage), Lee County, AL. The tributary is a clear headwater stream with sand and gravel substrate and well-defined pools and riffles. The nest occurred below a riffle and above a deep pool that was 0.5-1 m deep and had a cover of overhanging vegetation. Water temperature was 15°C. Male *C. pauciradii* were actively digging in the nest during the observation.

Male *N. zonistius* held loose, moving territories over the nest. Intruding conspecific males were chased by the territorial males, or males engaged in brief lateral displays and maintained their respective territories. Territorial males had dark purple bodies with a silver sheen, orange fins, and a pronounced black band in the dorsal fin. Smaller males were not as brightly colored, and did not successfully hold territories. Females were not as brightly colored as males, and fewer were present over the nest at any given time.

In a typical spawning episode, a female entered the nest from an adjacent area and approached a male. If she was not chased away, the male and female pressed their bodies together laterally and swam down to the substrate, where the pair vibrated, presumably releasing gametes. Other males rapidly joined the pair, getting as close as possible and perhaps also releasing sperm in an attempt to fertilize eggs.

Smaller males, with an orange rather than black band in the dorsal fin, maintained positions around the periphery of the nest and made periodic attempts to enter it. They were chased from the nest by larger males.

Male *C. pauciradii* were observed digging pits in the gravel in a manner similar to that described for *C. anomalum* (Hankinson, 1920; Miller, 1962). Several males dug in the same pit, maintaining only loose, moving territories. The *C. pauciradii* made no attempt to drive away the *N. zonistius*. Elsewhere *C. pauciradii* has been reported to dig pits in the nests of *Nocomis leptcephalus* (Maurakis and Kahnke, 1987).

In April, 1987, two spawning aggregations of *N. zonistius* were observed in Douglas Creek (Chattahoochee drainage), Harris County, GA. This creek is similar in size and other characteristics to the tributary to Halawakee Creek. On 19-20 April, an aggregation of about 12 male *N. zonistius* was observed over a *N. leptcephalus* nest about 45 cm in diameter, located at the head of a riffle. On 26 April, a male *N. leptcephalus* was observed over his nest in a gravel run at the head of a bedrock riffle in the same stream. The following day an aggregation of cyprinids was seen over the nest. All individuals were seined, identified, and released; ten *N. zonistius*, six *N. leptcephalus*, and six *C. pauciradii* were present. On 29 April, only *C. pauciradii* and *N. zonistius* were present over the nest.

The spawning of *N. zonistius* over the nests of other minnows described here is similar to that previously described for other members of the subgenus *Luxilus*. *Notropis coccogenis* has been observed spawning

over *N. micropogon* nests (Outten, 1957), with males guarding territories over the nest, and spawning occurring when a female entered the nest and approached a male from behind. The pair then swam to the substrate and vibrated. Pflieger (1975) reported that *N. zonatus* spawned over the nests of *Nocomis* and *Campostoma* in gravel depressions excavated by a male. Raney (1940) observed *N. cornutus* spawning over gravel beds in running water, excavating small depressions in gravel or sand in running water, or utilizing nests built by other species, even when these nests occurred in pools. Often the pit excavated by a male was one originally started by *Campostoma* or *Semotilus*, although *N. cornutus* appeared to prefer the gravel nests of *Nocomis* and *Exoglossum*.

It is not known whether *N. zonistius* and other nest-associates prefer the nests of *Campostoma*, *Semotilus*, *Exoglossum*, and *Nocomis* because of an attraction to the nest and the nest-guarding male, or whether they are merely taking advantage of the clean gravel in the nest, a spawning substrate that may not be available elsewhere in the stream. Clean gravel may provide better aeration for eggs than other types of substrate, and may reduce the incidence of fungal infection of the eggs. Eggs which fall between the interstices of the gravel may be afforded more protection from predators than if they are exposed, such as over mud, sand, or plants. Fishes that build gravel nests not only clean the gravel as it gathered, but also cover eggs with gravel as they are laid. This provides protection from egg predators. Additional protection from predators may be provided by the presence of the nest building fish itself. Male *Nocomis* are known to drive away egg predators (Hankinson, 1932).

The advantage to the nest building species of having nest associates is difficult to understand, since associates do not contribute to nest building. Nest building *Nocomis* tolerate nest associates (Hankinson, 1932; Reighard, 1942), while *Exoglossum* attempts to drive *N. cornutus* from their nests (Van Duzer, 1939). It may be too costly energetically to keep other species from the nest, since large numbers of fishes are often over it at one time. Another possibility is that there is a 'dump nest' effect produced by large numbers of eggs of other species. Predators are more likely to eat the eggs of nest associates if there are more of them. A disadvantage of having other eggs in the nest is that fungus might be more likely to become established and spread to all the eggs. These ideas are yet to be explored.

It is also not known whether nest association is obligatory or facultative. It may be obligatory for some species and facultative for others, such as *N. cornutus* (Raney, 1940). The number of accounts of nest association for some minnows, and the apparent availability of suitable spawning substrate elsewhere in streams suggests that an obligate spawning association has evolved for some species. Even the gravel depressions dug by male *N. cornutus* were begun by nest-building minnows (Raney, 1940). Broadcasting eggs away from nests, as occasionally happens in nest-associating species, may represent a reversion to a primitive state in the absence of nest-builders. Such reversion is known among darters (Page and Simon, in press). Further study of minnow nest associations should yield new insights into the evolution and ecology of this spawning strategy.

## Spawning in the Bandfin Shiner

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STRATIGRAPHY AND DEPOSITIONAL ENVIRONMENTS OF THE TURNIPSEED  
DINOSAUR SITE IN THE UPPER CRETACEOUS DEMOPOLIS  
CHALK OF MONTGOMERY COUNTY, ALABAMA<sup>1</sup>

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ABSTRACT

Bones of a carnivorous tyrannosaurid dinosaur, comprising the most complete specimen known from Alabama, were found 9.7 m above the base of the Upper Cretaceous Demopolis Chalk. Based on stratigraphic position, the age of the specimen is earliest Late Campanian. The bones occur in a section comprised of marine marl and calcareous clay containing distinctly shelfal trace- and body-fossil assemblages. The occurrence of numerous bones from a single terrestrial carnosaur in these marine shelf deposits indicates that the carcass was transported from land to this site. Characteristic bi-directional to multidirectional bone-orientation data demonstrate that storm waves rearranged the bones after disarticulation of the carcass on the sea floor. Examination of the dinosaur bone bed reveals basal scour in addition to normal grading and floating bone clasts. These features demonstrate that a rapid suspension fallout occurred after a high-energy event. High-energy, storm wave-induced scour and suspension of shelf marls on one or more occasions best account for the observed bone orientations, sedimentary structures, and faunal similarity between the dinosaur bone bed and other beds at the site.

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<sup>1</sup>Manuscript received 1 February 1988; accepted 4 April 1988.

# The Turnipseed Dinosaur Site

## INTRODUCTION

On July 2, 1982, the first two authors discovered bones of a carnivorous tyrannosaurid dinosaur in Montgomery County, AL, during field work centered on depositional environment and stratigraphic facies analyses of the lower part of the Selma Group in central and eastern Alabama (King, 1983 and 1987; King and Skotnicki, 1986). This report gives a description of the stratigraphic position and sedimentology of the dinosaur site and an interpretation of the site's depositional history and mode of emplacement of the bones. This report is the only detailed analysis published on a dinosaur site in Alabama.

The four latter authors were involved in excavation of the dinosaur and the preparation of the bones. Most of the bones are in relatively good condition as compared with dinosaur bones found in other Coastal Plain units of Alabama and adjacent states. The bones are from a single individual and include two tibiae, one fibula, six metatarsals, portions of the pelvic girdle, five ungual phalanges (claws), eight phalanges (toe bones), two vertebrae, one maxilla, one premaxilla, one dentary, thirteen teeth, several partial ribs, and several unidentified bones including skull components. The dinosaur bones are catalogued in the Auburn University Museum of Paleontology (AUMP 2366) and are being prepared at the Red Mountain Museum. When preparation and study are complete, a descriptive paper on the dinosaur will be prepared.

To date, these are the most complete carnosaur remains from Alabama and rank as probably the best and most completely preserved tyrannosaurid found east of the Mississippi River (Russell, personal communication, 1986). Other dinosaurs from Alabama, including a carnosaur, have been described or mentioned by Lull and Wright (1942), Langston (1960), Dobie (1975), Horner (1979), and Lamb (1986).

## GEOGRAPHIC LOCATION

The dinosaur site is on the east side of the County Highway 101 (Old Pike Road), 1.77 road km north of U.S. Highway 82 at the Downing crossroads in southeastern Montgomery County (Fig. 1). The site is approximately 108 m above mean sea level and located nearly at the center of SE1/4, NE1/4, NE1/4, Sec. 35, T14N, R20E. The dinosaur remains were on land owned by Mr. and Mrs. Sidney Turnipseed, Sr., and were excavated with their permission. All fossil material has been removed from the site, now designated the Turnipseed Dinosaur Site (T. D. S.).

## STRATIGRAPHIC POSITION AND AGE

The stratigraphic position of the T. D. S. is determined by a serial-section projection of measured sections along a north-south longitude encompassing the site. The projection method uses elevations, geographic locations, and an estimate of local dip (in this instance, 7.5 m/km due south) determined from nearby water wells to arrive at the stratigraphic relations among measured sections along the given latitude (King, 1987). The stratigraphic relations among the measured sections

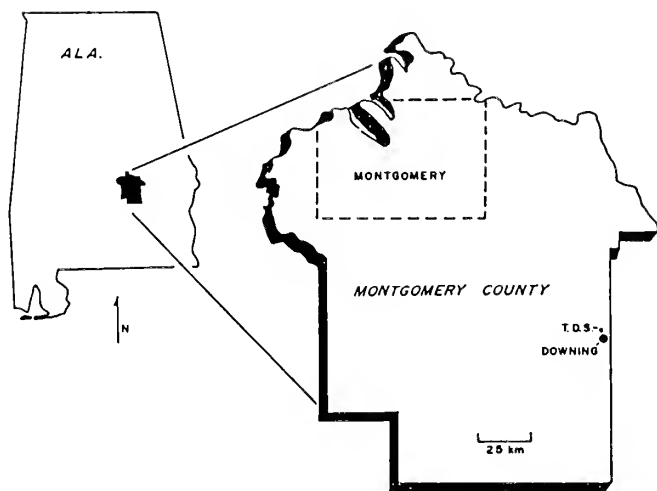


Figure 1. Location of the T. D. S. in relation to Downing, Montgomery County, Alabama.

near the T. D. S. is shown in Figure 2. The dinosaur bones, resting at a level between 1.2 and 1.5 m above the base of measured section 2, occur 14.9 m higher stratigraphically than the marker limestone bed (Fig. 2). The marker limestone is the most persistent limestone bed in the Arcola Limestone Member of the Mooreville Chalk (Fig. 3) and is the second youngest of the four limestones in the interbedded limestones and marls of the Arcola (King, 1987).

The Arcola Limestone Member of the Mooreville Chalk comprises the uppermost beds of the Mooreville Chalk (Fig. 3) whereas the Demopolis Chalk, which contains the dinosaur bones, overlies the Mooreville (Fig. 3). The base of the Demopolis Chalk is defined by stratigraphers in two different ways. For some, the base of the Demopolis is the marl layer resting on top of the highest limestone in the Arcola (Copeland, 1968; Russell and Keady, 1983). Others say the base of the Demopolis is marked by a conglomerate layer composed of phosphatic clasts, phosphatized shell molds, teeth, and bones of various taxa (Monroe, 1941; Frey and Bromley, 1985). The latter definition is the better because a minor faunal discontinuity occurs at the conglomerate level (Smith and Mancini, 1983) and because the most persistent and easily correlatable bed of limestone in the Arcola of east Alabama (Fig. 3) is not the highest limestone bed (King, 1987).

The stratigraphic position of the dinosaur bone bed with respect to the basal Demopolis conglomerate is shown in Fig. 2. The basal conglomerate (CGL on Fig. 2), identical to that described by Monroe (1941) and Frey and Bromley (1985), is 9.7 m below the dinosaur bone bed according to the correlation (Fig. 2).

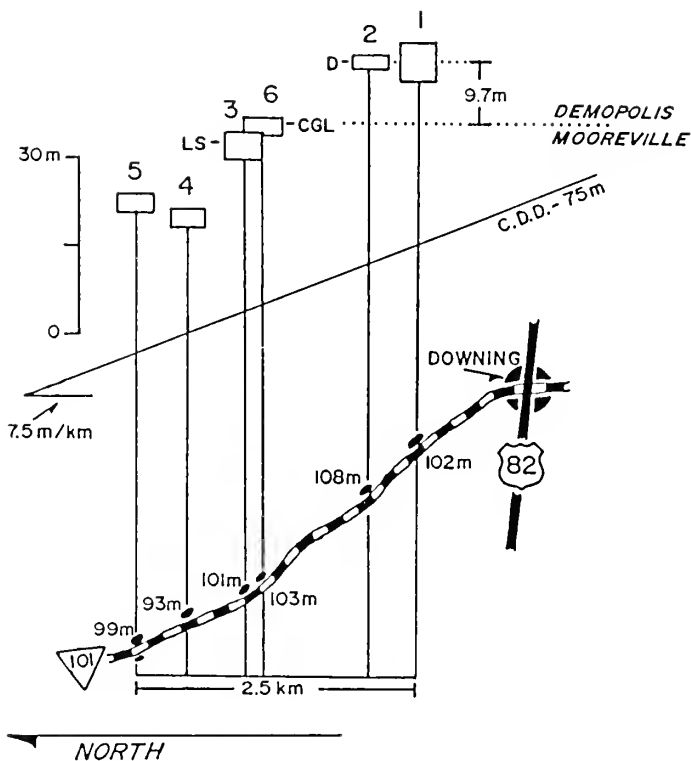


Figure 2. Serial-section projection. Lower part shows measured-section locations along County Hwy. 101 and their basal elevations to the nearest meter. Upper part shows sections in their proper stratigraphic position relative to a corrected-dip datum (C.D.D.) of 75 m. Inclination of the datum corrects for the 7.5 m/km south dip. Measured section 2 is the T. D. S.; D marks the level of the dinosaur bone bed. CGL marks the level of the conglomerate; L, the marker limestone.

The stratigraphic position of the bone bed is in the lower Demopolis, an interval which Sohl and Smith (1980) and Smith and Mancini (1983) have determined to be earliest Late Campanian in age. According to Harland *et al.* (1982), the entire Campanian Stage is bracketed by ages of 73 and 83 Ma. The age of the T. D. S. specimen is near the middle of this age range.

### SEDIMENTOLOGIC DESCRIPTION

The lithology of Demopolis Chalk at the T. D. S. is marl and calcareous clay; no true chalk occurs in the Demopolis of central Alabama

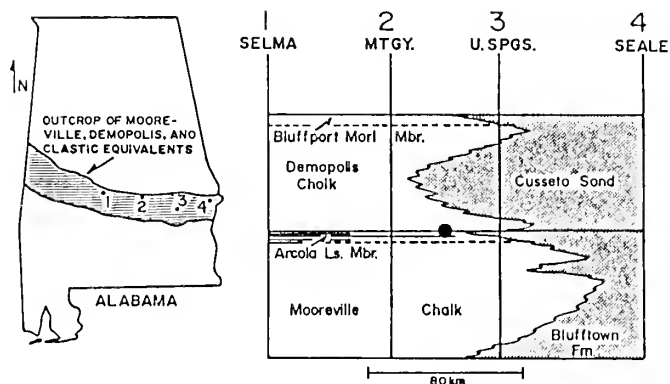


Figure 3. Mooreville-Demopolis and clastic-equivalent outcrop belt in Alabama (left) and generalized stratigraphic relations determined from composite measured sections (1-4). Black dot indicates stratigraphic position of correlation in Figure 2. Limestone beds in Arcola are black lines; the most persistent bed extends far to the east. Dashed lines indicate bases of members.

(King, 1987). According to Berger (1974) and Scholle *et al.* (1983), marl is a hemipelagic sedimentary rock with 30 to 70% pelagic calcareous components, whereas chalk has over 70% calcareous components and calcareous clay has less than 30%. The pelagic calcareous fraction of the Demopolis Chalk is a mix of foraminifera and calcareous nannoplankton (coccoliths and rhabdoliths).

The measured section at the T. D. S. (Fig. 4) consists of four sedimentological units: (1) a lower tan-grey silty marl (0 to 0.61 m); (2) a tan sandy marl (0.61 to 1.22 m); (3) a tan silty to sandy normally graded marl (1.22 to 1.52 m), which contained the dinosaur bones; and (4) an upper brown-yellow non-fossiliferous calcareous clay (1.52 to 2.44 m). From this point on, these are referred to as Units 1 - 4.

The amount and distribution of coarse clastic material varies among the sedimentological units (Fig. 4). Unit 1, a silty marl, contains 15 to 20% silt and fine sand and a trace of comminuted sand-sized muscovite and biotite flakes. Some silt and fine sand is concentrated in isolated burrows but most is dispersed throughout the sediment. Unit 2, a sandy marl, contains less total silt and sand (5 to 10%) than Unit 1 but the sand is slightly coarser, occurring in the fine and medium size classes. Together, Units 1 and 2 comprise a continuous coarsening-upward sequence from silt to medium sand. Unit 3, a marl, contains silt and fine sand, but has less silt and sand (1 to 5%) than marl Units 1 and 2. A thin layer of fine sand containing finely macerated wood fragments occurs intermittently along the base of Unit 3. Unit 3 shows normal grading with maximum clastic grain size decreasing upward from fine sand to silt. Unit 4, a calcareous clay, is silty near the base and grain size

# The Turnipseed Dinosaur Site

becomes coarser upward with medium sand occurring near the top. The average silt and sand content of Unit 4 is 15%.

Although the sediment in all four units is generally bioturbated, some burrow types are distinct (Fig. 4) and ichnogenera are identifiable. Units 1 and 2 contain horizontal to obliquely inclined burrows. The plan of these burrows indicates that they are *Thalassinoides* (large, tubular, and branching), *Planolites* (tubular and unlined), and *Chondrites* (minute, tubular, and branching). Unit 3 contains vertical burrows, 2 cm in diameter, of an unknown ichnogenus. These vertical burrows rarely branch and are filled with a carbonaceous blue-grey clay. A scour surface truncates the burrows and the overlying calcareous clay

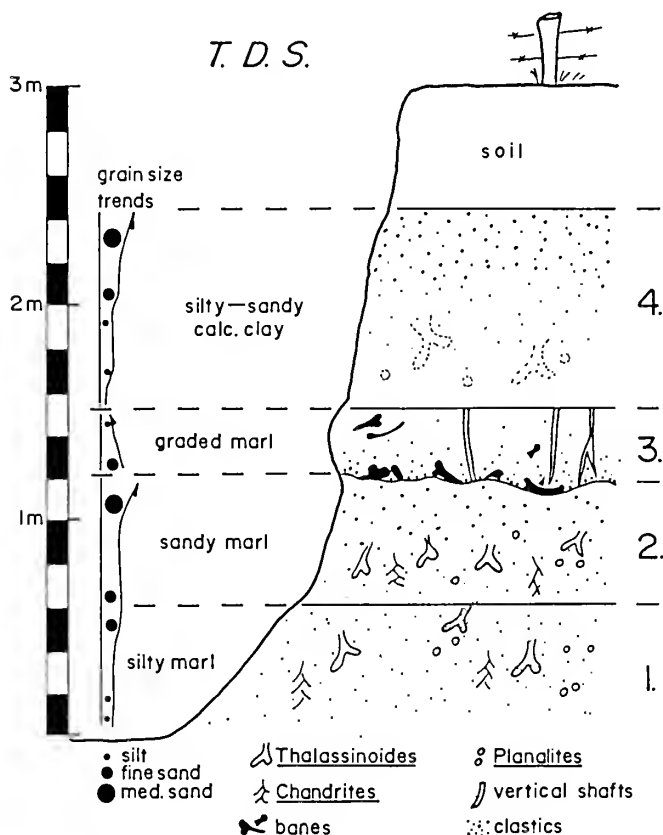


Figure 4. Measured section of the T. D. S. (section 2 in Fig. 2) showing the distribution of clastic content, trace fossils, and dinosaur bones. Relative change in grain size of coarse clastic component is shown at left.

unit contains no similar burrows. The vertical burrows do not penetrate through Unit 3 into the underlying sedimentological unit. Unit 4 contains only very poorly preserved *Thalassinoides* and *Planolites*.

The non-dinosaurian megafauna at T. D. S. have been examined in detail by two of the authors (Tables 1 and 2). The invertebrate portion of the observed megafauna consists of molluscs, some of which are leached and preserved only as impressions in the sediment (Table 1).

The non-dinosaurian species are nearly identical in each of the three marl units but the relative abundance of these species differs between units with the greatest abundance occurring in Unit 3. Microfossils in the marls include coccoliths, rhabdoliths, foraminifera, ostracodes, and fish scales.

Table 1. Molluscan megafauna and their preservation. T. D. S. marls, Units 1, 2, and 3. Identification by authors Bell and Lamb.

FOSSIL	PRESERVATION
<i>Ostrea plumosa</i>	calcified
<i>Liopistha inflata</i>	impression
? <i>Pholadomya</i> sp.	impression
<i>Anomia perlineata</i>	calcified
<i>Anomia tellinoides</i>	calcified
<i>Pecten simplicius</i>	calcified/impression
<i>Turritella trilirata</i>	impression
<i>Nemodon eufaulensis</i>	impression
<i>Leptosolen ?biplicata</i>	impression
<i>Exogyra ponderosa</i>	calcified

Table 2. Non-dinosaurian vertebrate fauna and their affinity. T. D. S. marls, Units 1, 2, and 3. Identifications by authors Bell and Lamb.

FOSSIL	AFFINITY
<i>Squalicorax kaupi</i>	Crow shark
<i>Scapanorhynchus texanus</i>	Goblin shark
<i>Cretolamna appendiculata</i>	Mackerel shark
<i>Ischyrohiza mira</i>	Ganopristine sawfish
Pycnodontidae	Holostean fish group
<i>Enchodus</i> sp.	Salmonid-like fish
Testudinea	Marine turtle

## The Turnipseed Dinosaur Site

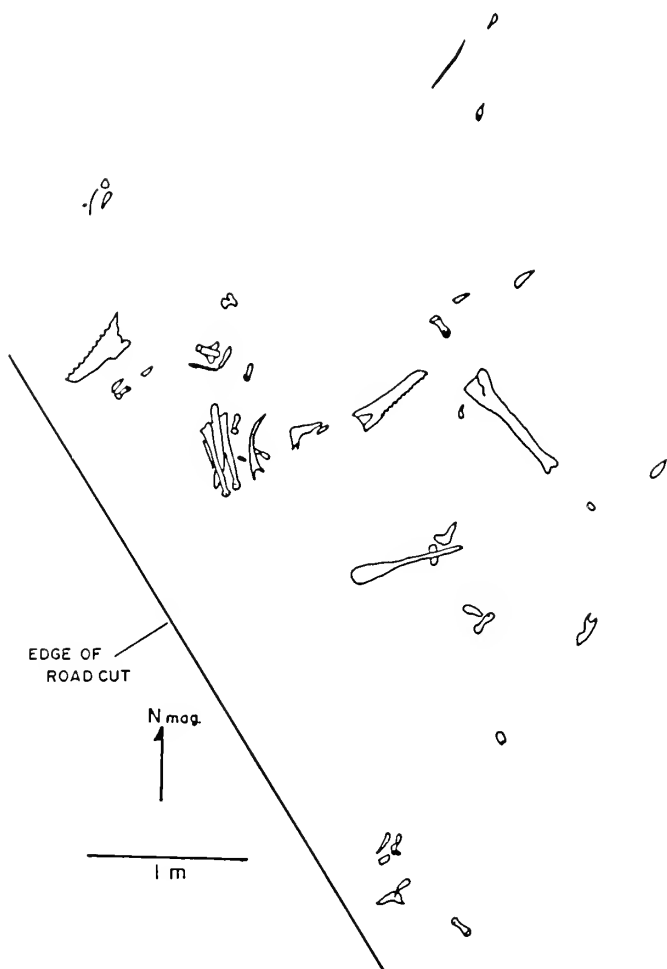


Figure 5. Plan view of *in situ* bone distribution at and near the base of sedimentological unit 3 at the T. D. Site. Bones shown are those excavated by Bell and Lamb and represent approximately 80% of all bones at the site. This is a composite map made from field notes of several excavations.

Most of the dinosaur bones were located at and near the base of Unit 3. However, a few were located in the graded marl matrix above its base. Such bones are referred to as floating bone clasts (Reif, 1982). The bones are not abraded, have no predation scars or borings, bear no epifauna such as barnacles or oysters, and were confined exclusively to Unit 3.



The dinosaur bone-bearing bed, Unit 3, was extensively excavated in several stages by two of the authors, Bell and Lamb. Figure 5 shows a composite of their sketch maps showing approximate spatial distribution of bones noted during the several excavations. The orientation of bones was noted during the final excavation stage when most of the bones were taken out. Figure 6 shows the long-axis bearing of the these bones and their shapes. The long-axis bearing is defined as the long-axis direction with polarity toward the largest end of the bone.

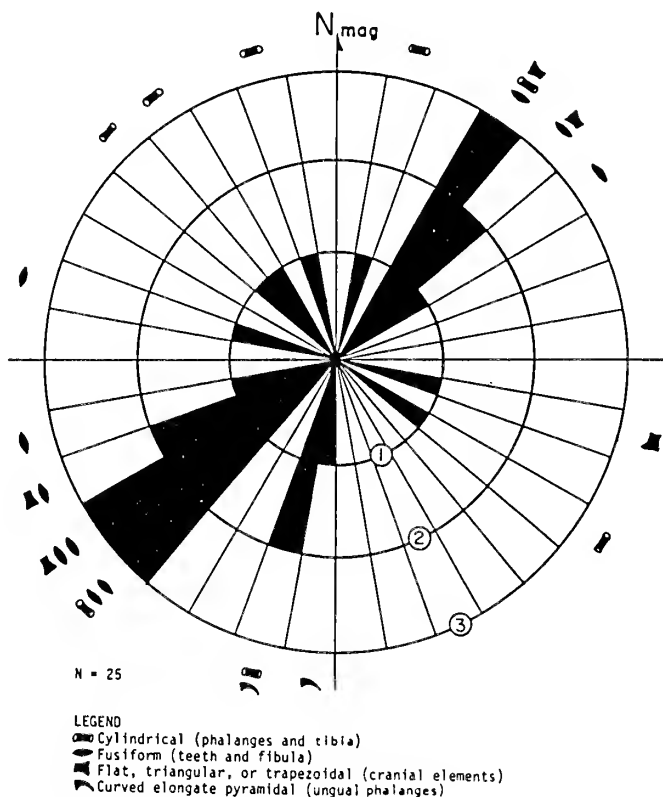


Figure 6. Rose diagram showing (in 10 degree increments) the long-axis bearings of 25 bones from the T. D. Site. Long-axis bearing shows the long-axis direction and the large-end polarity. Bone types in each increment are indicated by symbols. Each ring represents one long-axis bearing per increment.

## The Turnipseed Dinosaur Site

### DEPOSITIONAL HISTORY

#### *The Turnipseed Dinosaur Site*

Marl and calcareous clay found in the T. D. S. measured section are part of the Selma shelf hemipelagic deposits (Reinhardt, 1980; King, 1987). Nearly identical lithologies and fauna in the underlying Mooreville Chalk have been interpreted as inner- and middle-shelf deposits (King and Skotnicki, 1986; King, 1987). The burrow types occurring at T. D. S. are the same as those found in typical shallow shelf-sea deposits (Ekdale and Bromley, 1984) comparable to the Selma shelf which have probable water depth of 30 to 100 meters (Ekdale *et al.*, 1984).

The sand and silt grains found in the sediment and in burrow fillings indicate periodic clastic input from an adjacent shoreline source (Mount, 1984). Walker (1985) described several currents of meteorological origin which could have moved sand beyond the shoreline and onto an ancient shelf such as the Selma shelf. These include rip currents, incremental storm flows, storm-surge ebb currents, wind-forced currents, and turbidity currents. General thorough bioturbation probably caused the coarse clastics (silt and sand) to be dispersed throughout the hemipelagic sediment (Mount, 1984).

The marls of Units 1 and 2 and the calcareous clay of Unit 4 show coarsening-upward trends in clastic grain size (Fig. 4) which can be attributed to two small-scale sedimentary cycles. Such sedimentary cycles may develop in response to sea-level changes or climatic influence, such as alternating wet and dry cycles. Coarsening-upward cycles of similar thickness situated between limestones in the underlying Arcola Limestone Member of the Mooreville Chalk have been interpreted to be the result of small-scale sea-level cycles (Castleman and King, 1986; King, 1987). Climatic influence as an alternative explanation of cycle genesis seems unlikely because no vertical trends of climate-sensitive parameters such as organic-carbon content (determined by sediment color) occur in either T. D. S. cycle. Thus the coarsening-upward cycles in the T. D. S. probably were formed by small-scale sea-level fluctuations.

#### *The Dinosaur Bone Bed*

Unit 3, the dinosaur bone bed, shows evidence of rapid deposition, i. e., normal grading and floating bone clasts. The vertical-shaft trace-fossil morphology also suggests rapid deposition. Such shafts are indicative of opportunistic fauna which rapidly inhabit redistributed bottom sediments (e. g., high-energy storm event beds in Cretaceous strata of the Western Interior Seaway; Pemberton and Frey, 1984). The carbonaceous-clay filling and truncation of these vertical shafts are evidence that pre-Unit 4 sedimentation was removed by scour and not preserved elsewhere at the T. D. Site.

Rapid marine deposition like that found in Unit 3 may occur in a single density-flow event moving down slope (Walker, 1985) or in an episode of scour and suspension of fines by storm wave action (Kreisa, 1981). The floating bone clasts and normal grading in Unit 3 reflect

suspension fallout and do not aid in distinguishing between the two possible modes of origin presented above (Kreisa and Bambach, 1982). On the other hand, bone-orientation data (Fig. 6) and non-dinosaurian megafaunal content are useful in determining how the dinosaur bone bed was deposited as described below.

Storm-generated beds generally show a multidirectional to bi-directional pattern of paleocurrent indicators (Gray and Benton, 1982) whereas density-flow deposits show a more nearly unidirectional pattern because of the strong effect slope has on current direction (Walker, 1985). Elongate bones with cylindrical, fusiform, or pyramidal shapes tend to be aligned with their long axes parallel to current (Hanson, 1980) and oriented very commonly with their large ends downcurrent (Voorhies, 1969; Hunt, 1978). Therefore, elongate bones possessing a large end effectively serve as absolute paleocurrent indicators in sedimentary systems. The T. D. S. data, consisting of 25 long-axis bearings (Fig. 6), demonstrate two main downcurrent directions, one to the southwest (9 bearings) and another to the northeast (6 bearings). Apart from the 15 bearings in these two opposing modes, the remaining ten long-axis bearings indicate several other current directions. Thus, the bone-orientation data from T. D. S. indicate the bi-directional to multidirectional paleocurrents typically associated with storm-wave action on the sea floor (Gray and Benton, 1982).

Storm-wave suspension of marls is further supported by the fact that the dinosaur bone-bearing unit contains essentially the same non-dinosaurian megafauna as the underlying units even though the concentration of that megafauna is greater within the bone bed. Similarity of faunas combined with differences in abundance are characteristic of storm scour-formed, autochthonous shell beds in shelf deposits of the geologic record (Brenner and Davies, 1973; Kreisa, 1981; Kreisa and Bambach, 1982).

#### DISCUSSION

The assemblage of over four dozen bones in an area of several square meters (Fig. 5), all apparently from a single carnosaur and all in good condition, suggests that a single carnosaur carcass was first transported offshore by currents and was subsequently deposited at the T. D. Site. This is the most probable explanation and, in support of this contention, we note that other terrestrial flotage including mollusc-bored wood pieces have been found in Selma shelf marls many kilometers from the inferred shoreline location (Applegate, 1970; Wylie, 1985). Based on correlation of facies relations in the basal Demopolis-Cusseta package, including the T. D. S. section (King, 1987; Skotnicki and King, unpublished), a coeval shoreline with nearshore clastic facies occurs 15 to 20 km east of the T. D. S.; this shoreline is a likely source of the carcass.

After disarticulation of the carcass on the sea floor, storm waves scattered and oriented the bones. The more transportable bones, e. g., vertebrae (Hanson, 1980), were probably moved away from the site in this manner. The same storm or a subsequent storm also scoured the sea floor

thus generating the suspension-fallout (graded marl) layer above the bone-laden basal scour (Reif, 1982).

Marsaglia and Klein (1983) predicted that the effects of major storms would be common in the stratigraphic record of the Selma shelf. They based this prediction on a study of the paleogeography of the Late Cretaceous Gulf of Mexico and the tracks of modern hurricanes and tropical storms developing in or entering the present Gulf, and the fact that a slightly warmer-than-present climate of that time would have spawned more tropical storms per season. To date several studies, e. g., King and Skotnicki (1986), have described storm-generated sedimentary structures and features of the Selma shelf deposits, particularly the Demopolis and Mooreville Chalk. In addition to the storm-wave effects found in the Demopolis at T. D. S., several occurrences of high-energy storm deposition exist in the upper 50 m of the underlying Mooreville Chalk (Skotnicki and King, 1986; King and Skotnicki, 1986) and the Arcola Limestone Member of the Mooreville (Castleman and King, 1986; King, 1987). This information suggests that conditions were correct for many storms to occur on the shelf and their effects include the deposition of the dinosaur bone bed at the T. D. Site.

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RESOURCE DIRECTORY

ALABAMA ACADEMY OF SCIENCE

PREFACE

The Alabama Academy of Science was founded in 1924 to foster and enhance the advancement of science in Alabama. It has provided a forum, through paper presentations at the annual meetings and through The Journal of the Alabama Academy of Science, for reporting research and research findings. It also sponsors the Alabama Junior Academy of Science and supplements university research programs throughout the state. For most of its years, the membership has communicated only with itself (this a normal function of any scientific association). However, in the last few years, believing that growth and development in any state is related in many ways to a closer relationship of science and industry, the Academy has sought to communicate with the Alabama community at large.

This Directory lists those Academy members willing to serve the state in the capacities indicated under their names. Names are entered under a heading corresponding to the section of the Academy to which the member belongs. A copy of the Directory questionnaire is included so that the reader will have a legend to follow in reading each entry. The Directory will go to each Academy member with this issue of the Journal. Additional copies are to be provided to University administrations, industrial leaders, government leaders, and Chambers of Commerce in Alabama. In this manner the Academy seeks to make itself available as a resource to be used for development of Alabama.

Finally, a list of Academy members who have served in the office of President is provided to depict the historical basis of this important scientific group. Many of these persons are still active in research and publication. Additionally, they often assist in the kinds of research that moves the State forward (as shown in the Directory).



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Name, Position, and Institution:

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What you can contribute to the development of Alabama? (concise one line statement)

I Am Willing: (Place a check mark for each area below in which you are willing to serve.)

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- (    )    3. to appear before a legislative committee to provide expertise (mileage, etc. paid).
- (    )    4. to contribute up to \_\_\_\_\_ days per year
  - (    )    A. to individual work, or
  - (    )    B. as a resource team member in preparing a report.
- (    )    5. to serve in preparing longer reports for a research consulting activity individually or as a team member.
- (    )    6. to work summers in government/industry as a research intern.
- (    )    7. to do original research for government/industry.
- (    )    8. to work with a high school student on a science project.
- (    )    9. to speak before educational, business, and governmental groups.

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ADAMS, CAROLINE, Associate Professor of Biology, Auburn University at Montgomery; 277-4619 (h), 271-9332 (o); Biological Sciences, Section I; Ph.D., Southern Illinois University; Research and publication in the area of reproductive physiology; 1, 7, 8.

APPEL, ARTHUR G., Assistant Professor of Entomology, Auburn University; 821-6767 (h), 826-5006 (o); Urban Entomology, Section I; Ph.D., University of California, Riverside; Physiological and behavioral ecology of urban pests and urban pest management; Evaluate new compounds and tactics to control urban pests; 1, 2, 3, 6, 7, 9.

BAILEY, MARK A., Graduate Student, Zoology and Wildlife Science, Auburn University; 821-6429 (h), 826-4850 (o); Zoology, Section I; B.S., Auburn University; Ecology and migrating behavior of gopher frogs; Information on ecology, distribution, and management of native vertebrates; 2, 4-5-A-B, 7, 8, 9.

BEASLEY, PHILIP G., Chairman & Professor, Department of Biology, University of Montevallo; 665-2713 (h), 665-6458 (o); Fisheries, Section I; Ph.D., Auburn University; Herbicide residues in aquatic environments; Consult with leaders in government, education, and business on the development of educational reform and science curricula; 2, 3, 4-5-A-B, 5, 9.

BECK, MARY JIM, Biologist/Project Manager, Tennessee Valley Authority; 767-2850 (h), 386-2649 (o); Microbial Biochemistry, Biology, Section I; Ph.D., Auburn University; Xylose fermentation, Biotechnology, Bioengineering & Biotechnology Letters; The research which I am involved with at TVA is for the purpose of production of liquid fuels from biomass. If the work is successful, it will mean production facilities in Alabama and the nation; 1, 2, 3, 4, 9.

BRADLEY, JAMES T., Auburn University; 887-7580 (h), 826-2202 (o); Biological Science, Section I; Ph.D., University of Washington; Cell/developmental biology of oogenesis and regulation of protein secretion; provide rationale for state/industry support of basic research; 9.

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**BRAID, MALCOLM R.**, Associate Professor of Biology, University of Montevallo; 665-4191 (h), 665-6459 (o); Biology, Section I; Ph.D., Auburn University; "A Bal-Chatrri Trap for Basking Turtles," "Incidence of Cannibalism Among Striped Bass Fry in an Intensive Culture System," "A Prime-Retaining Siphon for Use in Intensive Culture Systems," & "Alligators in Alabama;" a willingness to assist in data collection and preparation of reports relative to natural resources in the State; 1, 2, 3, 4-A-B, 5, 7, 8.

**BRANNON, MARY JANE**, Professor, Huntingdon College; 262-0321 (h), 265-0511 (o); Biology, Section I; Ph.D., Tulane School of Tropical Medicine; retired, but willing to serve as follows; 1, 2, 3, 4-6-B, 5, 6, 8, 9.

**BRIDKEY, P. JANE**, Graduate Research Assistant, Auburn University; 826-0313 (h), 826-4850 (o); B.S., Oklahoma State University; "Evaluation and Calibration of the U.S. Fish and Wildlife Service Habitat Suitability Index Model for Wintering American Woodcock."

**BROWN, JAMES EDWARD**, Auburn University; 257-3771 (h), 826-4862 (o); Horticulture, Section I; Ph.D., University of Illinois; "Production and Economic Returns of Three Vegetable Double-Cropping Systems" & "Production and Economic Returns of Vegetable Intercropping Systems,"; 1, 9.

**BUCKNER, RICHARD L.**, Associate Professor of Biology, Livingston University; 652-2263 (h), 652-9661 (o); Parasitology, Section I; Ph.D., University of Nebraska.

**CASELL, GAIL H.**, Chairman/Professor, Department of Microbiology, University of Alabama/Birmingham; 967-2618 (h), 934-9339 (o); Microbiology, Section I; Ph.D., UAB; "Isolation of Acholeplasma oculi from Human Amniotic Fluid in Early Pregnancy," & "Chronic Recurrent Multifocals Osteomyelitis: Are Mycoplasmas Involved?" Research in infectious diseases, infant morbidity and mortality; 1, 2, 3, 4-5-A-B, 5, 7, 8, 9.

**CLINE, GEORGE B.**, 871-9940 (h), 934-5250 (o); Physiology & Biology, Section I; Ph.D., SUNY, Upstate Medical Center, Syracuse, N.Y.; "Total Protein Analysis of the Eleven Developmental Stages of the Fresh Water Prawn, Macrobrachium rosenbergii, by Isoelectric Focusing"; provide biochemical and developmental analysis of larvae and post larvae of fresh water prawns and stone crabs; 1, 2, 7.

**COSTES, DANICE H.**, Professor of Biology, Troy State University; 277-6722 (h), 566-3000 (o); Entomology, Taxonomy, Biological Sciences, Section I; Ph.D., North Carolina State University; Cercopidae; Entomology - from the standpoint of health - - control of insects, taxonomy; 1, 2, 4-2-A, 5, 6, 7, 8.

**DARDEN, WILLIAM H., Jr.**; Chairman/Professor, Department of Biology, University of Alabama; 553-5058 (h), 348-5960 (o); Ph.D., Indiana University; Development and Life History of Volvox; 1, 2, 3, 9.

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DAVIS, DONALD E., Professor Emeritus of Botany (Weed Science), Auburn University; 887-8166 (h), 826-4830 (o); Section I; Ph.D., Ohio State University; Provide expertise in herbicide uses, mode of action, and environmental effects; 2, 3, 4-A or B, 5, 9.

DIAMOND, ALVIN ROOSEVELT, Jr., Research Assistant, Biology, Auburn University; 826-4830 (o); Systematic Biology, Section I; M.S., Auburn University; "A Flora of the Mesic Ravines of the Central Red Hills of Alabama;" Field research on endangered or threatened species; 1, 2, 8, 9.

DIENER, URBAN L., Professor Emeritus, Department of Plant Pathology, Auburn University; 887-5606 (h), 826-5003 (o); Section I; Ph.D., North Carolina State University; Aflatoxin in peanuts, corn and cottonseed; Diseases of horticultural crops; provide advice on the control of aflatoxin in corn and/or peanuts and control of fungi in stored grain and other crops. Provide information on other mycotoxins; 1, 2, 3, 4-15-A-B, 5, 7, 8, 9.

DIXON, CARL F., Associate Professor, Auburn University; 887-3178 (h), 826-4850 (o); Parasitology, Zoology, Section I; Ph.D., Kansas State University; Parasites and wild animals; Provide education in area of expertise at university level; 2, 3, 4-30-A-B, 9.

DUSI, JULIAN L., Professor of Zoology and Wildlife Sciences, Auburn University; 887-6406 (h), 826-4850 (o); Mammalogy and Ornithology, Section I; Ph.D., Ohio State University; "Ecology of the Black Bear in Southwest Alabama" and "Thirty-four-year Summary of the Status of Heron Colony Sites in the Coastal Plain of Alabama, USA;" Provide environmental analysis of birds and mammals and other vertebrate species; 1, 2, 3.

EMERT, GEORGE H., Executive Vice President, Auburn University; 887-3724 (h), 826-4650 (o); Biochemistry, Section I; Ph.D., Virginia Polytechnic Institute and State University; The conversion of renewable resources to useful organic chemicals; Provide expertise with regard to the utilization of biotechnology and cellulose utilization; 1, 2, 3, 8.

FLEMING, THOMAS V., Graduate Student, University of Alabama/Birmingham; 934-8304 (o); Mammalogy, Section I; B.S., Shippensburg University of Pennsylvania; "Seasonal Dynamics in an Alabama Pine Vole Population"; 4-14-A-B, 6, 7.

GAUTHIER, JOSEPH J., Associate Professor of Biology, University of Alabama/Birmingham; 870-7059 (h), 934-5659 (o); Applied & Environmental Microbiology, Section I; Ph.D., UCLA; Ground water pollution and industrial waste treatment; 2, 3, 6, 7, 9.

GLAZE, ROBERT P., Vice President for Research & Institutional Advancement, University of Alabama/Birmingham; 879-9017 (h), 934-3786 (o); Biochemistry, Section I; Ph.D., University of Rochester; Provide expertise in science policy, research administration, research capacity development, and university administration; 1, 2, 3, 4-10-A-B, 5, 9.

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GOODE, PAULA R., Environmental Technician, Farley Nuclear Plant, Alabama Power Company; 792-6998 (h), 899-5156 (o); Biology, Chemistry, Section I; B.S. Biology, Belmont College; Provide guidance in the operation of a commercial nuclear power station with regards to environmental monitoring, chemistry, and health physics; 1, 2, 3, 8, 9.

GRIZZLE, JOHN M., Associate Professor of Fisheries, Auburn University; 749-3170 (h), 826-4786 (o); Fish Pathology, Section I; Ph.D., Auburn University; "Environmental Factors Affecting Fish Health" and "Fish as Test Animals for Assays of Chemical Carcinogenicity;" Determine the effects of pollutants and pathogens on fish, including the impact on aquaculture and sport fish populations; 1, 2, 3, 7, 8.

HENDERSON, J. H. M., Professor of Biology, Tuskegee University; 727-3272 (h), 727-8873 (o); Plant Physiology (Tissue Culture), Biology, Section I; Ph.D., University of Wisconsin; "In Vitro Culture of the Sweet Potato" and "Micropropagation of the Sweet Potato (Ipomea batatas) by In Vitro Culture;" 2, 3, 8, 9.

HENDRICKS, HARLAN J., Graduate Student, Auburn University; 821-1059 (h), 826-5006 (o); Ornamental Entomology, Section I; B.A., LaGrange College; "Obscure Scale Poses Serious Problem to Landscape Plantings of Pin Oak in Alabama;" Provide information on the identification and control of ornamental plant pests of Alabama; 1, 8, 9.

HOLLAND, LOUIS E., Head, Molecular Virology Section, Southern Research Institute; 581-2597 (o); Virology, Section II; Ph.D., University of California/Irvine; Gene mapping of herpes simplex virus & evaluation of compounds as antiviral agents; Provide technical expertise about AIDS and other human viral diseases; 2, 3, 4-2-B, 7, 9.

HOLLIMAN, DAN C., Professor of Biology, Birmingham - Southern College; 822-4155 (h), 226-4883 (o); Biology, Section I; Ph.D., University of Alabama/Tuscaloosa; Field research in mammalogy and ornithology; Proof read scientific papers in any field submitted for publication

HRIBAR, LAWRENCE J., Graduate Research Assistant, Auburn University; 826-5006 (o); Medical Entomology, Section I; M.S., University of Tennessee.

HUDGINS, MICHAEL D., Assistant Professor of Biology, Alabama State University; 288-1669 (h), 293-4299 (o); Biology, Section I; Ph.D.; "Structure of the Angling Experience" and "Probability Angling - A Recreational Fishery Management Strategy;" Provide analysis of recreation/sport fisheries; 1, 2, 3, 4-5-A-B, 5, 6, 7, 9.

JANDEBEUR, THOMAS S., Professor of Biology, Athens State College; 837-5722 (h), 232-1802 (o); Ichthyology, Biology, Section I; Ph.D., University of Alabama; Fishes of the Tennessee River System in North Alabama and South Central Tennessee; Provide knowledge of the distribution, abundance and ecology of mollusks, fishes, reptiles, and amphibians in North Alabama; 1, 2, 3, 4-12-A-B, 5, 6, 7, 9.

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KEMPF, STEPHEN C., Assistant Professor, Auburn University; 826-5145 (o); Biological Sciences, Section I; Ph.D., University of Hawaii; Invertebrate neural development; invertebrate larval ecology and algal - animal endosymbiosis. 1, 7.

KIRBY, ALBERT W., Neuropharmacologist, U.S. Army Aeromedical Research Laboratory, Ft. Rucker, Alabama; 393-2147 (h), 255-6815 (o); Neuroscience, Section I; Ph.D., Northwestern University; Transmitter and synaptic mechanisms in the vertebrate visual system; 1, 2, 3, 4 -?-A-B; 5, 8, 9.

KITTLE, PAUL, Associate Professor of Biology, University of North Alabama; 767-6260 (h), 760-4437 (o); Zoology, Section I; Ph.D., University of Arkansas; Provide advice about natural area establishment and management; 2, 3, 5, 7, 9.

LANE, JACQUELINE M., Adjunct Instructor, Pensacola Junior College, Warrington campus; (904) 453-5488 (h); Biological Sciences, Section I; Ph.D., University of South Florida; Energy relationships of marine invertebrate animals; Provide science education, especially in environmental areas; 1, 5, 7, 8, 9.

LARTEY, ROBERT T., Graduate Student, Auburn University; 887-5030 (h), 826-5003 (o); Plant Pathology, Section I; MSc., University of Reading, England (UK); Biological control and ecology of soil-borne diseases; 2, 7.

LELONG, MICHEL G., Professor of Biology, University of South Alabama; 460-6331 (o); Botany, Plant Taxonomy, Section I; Ph.D., Iowa State University; Taxonomic treatment of the grass genus, Panicum, of Southern United States and flora of Mobile and Baldwin Counties; 1, 2, 3.

LISHAK, ROBERT S., Associate Professor, Department of Zoology and Wildlife Science, Auburn University; 821-6447 (h), 826-5145 (o); Animal behavior, Biological Sciences, Section I; Ph.D., Ohio State University; "Vocalizations of Adult Gray Squirrels" and "Gray Squirrel Mating Calls: A Spectrographic and Ontogenic Analysis;" 1, 2, 6, 7.

LONG, CALVIN L., Corporate Director of Research, Baptist Medical Centers, Birmingham; 783-3329 (h), 969-3685 (o); Nutrition, Section I; Ph.D., University of Illinois; Interested in intermediary metabolism, metabolic responses to stress (trauma, sepsis, operations, cancer, starvation), and clinical nutrition; Improve the health care of hospitalized patients through the upgrading of clinical nutrition; 2, 7.

MARION, KEN R., Professor of Biology, University of Alabama/Birmingham; 956-8332 (h), 934-3582 (o); Environmental Studies and Vertebrate Ecology, Section I; Ph.D., Washington University (St. Louis); Reproductive cycles of reptiles and pollutant levels in bivalves of Mobile Bay; Provide environmental assessments and assess animal populations; 1, 2, 5, 9.



Directory of the Alabama Academy of Science

MASON, WILLIAM H., Assoc. Dean for Academic Affairs, College of Sciences and Mathematics, and Alumni Professor, Zoology and Wildlife Science, Auburn University; 887-7223 (h), 826-4269 (o); Zoology, Biological Sciences, Section I; Ed.D., University of Georgia; The Human Side of Biology (Harper & Row) and "Egg Production and Bioelimination of Iron-59 in Drosophila melanogaster;" Areas of interest include removing barriers to the handicapped, circuitous measurement of metabolism in invertebrates, alternative modes of instruction, and improvement of science education 1, 2, 3.

MARSHALL, JOHN E., Pollution Control Specialist, ADEM, Mobile Field Office; 342-0997 (h), 479-2336 (o); Wildlife Ecology, Section I; M.S., University of South Alabama; "The Effects of Nest Predation on Hatching Success in the Gopher Tortoise (Gopherus polyphemus, Dauden, 1802);" Provide knowledge of environmental conservation and natural resource management; 1, 2, 5, 8.

McCLINTOCK, JAMES B., Assistant Professor of Biology, University of Alabama at Birmingham; 969-3539 (h), 934-1034 (o); Invertebrate Zoology, Section I; Ph.D., University of South Florida; "Aquatic Invertebrate Reproduction, Nutrition, and Ecology;" Provide an assessment of aquatic invertebrate resources for the state; 1, 4-5-A, 7, 8, 9.

McCULLOUGH, HERBERT A., Distinguished Professor of Biology Emeritus, Samford University; 879-5120 (o); Botany, Biological Sciences, Section I; Ph.D., University of Pittsburgh; Author of Biology Textbook.

MIRARCHI, RALPH E., Associate Professor, Wildlife Science, Auburn University; 745-6945 (h), 826-4850 (o); Wildlife Ecology, Biological Sciences, Section I; Ph.D., Virginia Tech; Columbidae (Dove-Pigeon) Ecology; Provide information on Columbidae ecology and general wildlife conservation policies; 1, 2, 3.

MITCHELL, JOAN PARSONS, Assistant Dean and Instructor, College of Arts and Sciences, University of Alabama/Tuscaloosa; 349-4665 (h), 348-8539 (o); Biology/Genetics, Section I; Ph.D., University of Alabama/Tuscaloosa; Willing to act as a spokesperson for the biological sciences to the nonscience public, enjoy speaking to groups about science; 1, 3, 4-A-B, 5, 9.

MOORE, JACK H., Dean, School of Arts and Sciences and Professor of Biology, University of North Alabama; 766-8921 (h), 760-4288 (o); Biology, Section I; Ph.D., Auburn University; Mycotoxins and Cancer Chemotherapy; provide information related to higher education problems; 1, 2, 8, 9.

MOORE, TERESA KELLEY, Assistant Professor of biology, Troy State University; 566-0643 (h), 566-3000 (o); Genetics, Section I; M.S., North Carolina State University; "Characterization of Catalase - Synthesizing Polyribosomes in Maize;" I feel that I can aid in promoting awareness and education in the biological sciences, particularly in the genetics area; 8.

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MULLEN, GARY RICHARD, Associate Professor, Department of Entomology, Auburn University; 887-9991 (h), 826-5006 (o); Entomology, Section I; Ph.D., Cornell University; Medical - veterinary entomology/acarology, biting flies as vectors of disease agents, and ticks and lyme disease; 1, 2, 3, 7, 9.

MURPHREE, C. STEVEN, Graduate Assistant, Auburn University; 821-8307 (h), 826-5006 (o); Medical Veterinary Entomology, Biological Sciences, Section I; M.S., Middle Tennessee State University; "Morphology and Systematics of the Phalangida (Harvestmen)" and "Larval Morphology and Systematics of Culicoides (Diptera: Ceratopogonidae);" Identification and control of arthropod vectors of disease; 1, 9.

NIEDERMEIER, WILLIAM, Associate Professor, Division of Clinical Immunology & Rheumatology (retired), University of Alabama/Birmingham; 979-2668 (h); Biochemistry, Section I; Ph.D., University of Alabama/Tuscaloosa; Biochemistry and immunochemistry; 2, 3, 5, 7.

NELSON, DAVID H., Associate Professor of Biology, University of South Alabama, 342-8867 (h), 460-6331 (o); Ecology and Biological Sciences, Section I; Ph.D., Michigan State University; Natural history and population ecology of amphibians and reptiles; Conservation of natural resources, environmental stewardship, and natural history of terrestrial vertebrates; 1, 2, 3, 4-4-A-B, 5, 6, 7, 8, 9.

OTTIS, K., Professor of Physiology (retired), Auburn University; 887-5343 (o); Biological Sciences, Section I; Ph.D., Iowa State University; Serotonin: mechanism of action; provide stimulation of scientists to be productive in Alabama.

PETERSON, CURT M., Professor, Department of Botany & Microbiology, Auburn University; 821-1349 (h), 826-4830 (o); Botany and Biological Sciences, Section I; Ph.D., University of Oregon; 25 refereed papers on plant growth, development, and physiology; Provide research expertise related to the development of plant biotechnology for the agriculture and forest industry; 1, 2, 3, 4-12-A-B, 5, 7, 9.

PIERSON, J. MALCOLM, Senior Aquatic Biologist, Alabama Power Company; 668-1787 (h), 664-6177 (o); Fisheries Biology, Section I; M.S., Auburn University; Several articles on the distribution and life history of freshwater fishes in the Mobile drainage basin; Conduct environmental impact studies prior to beginning developmental projects; 5, 7.

PLAKAS, STEVEN M., Fishery Research Branch, FDA, Dauphin Island; 342-7624 (h), 861-2962 (o); Xenobiotic Disposition in Aquatic Animals, Section I; Ph.D., University of Rhode Island; Bioavailability, biodistribution, and residual persistence of xenobiotics in catfish; 1, 2, 3, 5, 9.

RAVIS, WILLIAM R., Professor of Pharmaceutics, School of Pharmacy, Auburn University; Pharmacokinetics, Section I; Ph.D., University of Houston; Areas of pharmacokinetics and drug absorption; 1, 7.

Directory of the Alabama Academy of Science

REGAN, GERALD T., Professor of Biology, Spring Hill College; 460-2187 (h), 460-2325 (o); Ecology, Section I; Ph.D., University of Kansas; Surf zone, dolphins; 1.

ROBINSON, GEORGE H., Professor of Psychology, University of North Alabama; 764-0506 (h), 760-4574 (o); Experimental Psychology, Section I; Ph.D., University of Mississippi; "Psychophysics" and "Psychophysical Methods;" Educate through teaching psychology; 1.

SHEA, CATHERINE, Assistant Professor of Microbiology and Biochemistry, University of Alabama/Tuscaloosa; 345-2683 (h), 348-5953 (o); Microbiology, Section I; Ph.D., University of Oklahoma; Marine bacterial adhesion and carbohydrate metabolism in Streptococcus mutans; Investigate the molecular processes involved in biofouling of surfaces by microorganisms; 1, 2, 3, 5, 7.

SINGH, SHIVA P., Professor of Biology and Director of Scientific Research, Alabama State University; 277-1748 (h), 293-4301 (o); Outer Membrane Proteins of Gram-Negative Bacteria, Section I; Ph.D., Auburn University; "Structural Proteins of Baculoviruses" and "Monoclonal Antibodies to the Major Outer Membrane Proteins of Salmonella typhimurium;" Provide expert consultation to the state, county, and local health agencies on bacterial food-poisoning and immunological methods for detection of the causative organisms; 1, 2, 5, 7, 8, 9.

SMITH, ROBERT, Professor of Biochemistry, Auburn University; 745-0168 (h), 826-4160 (o); Biochemistry, Section I; Ph.D., University of Illinois; Numerous publications in biochemical and microbiological journals; Provide information and solve problems in biochemical and microbiological areas; 1, 2, 5.

SIRADA, SAMUEL J., Chairman and Professor, Department of Pharmacology, University of South Alabama; 342-3608 (h), 460-6497 (o); Biological Sciences, Section I; Ph.D., Vanderbilt University; Cyclic nucleotide mechanisms of action and molecular actions of drugs; Provide expertise on basic pharmacology and toxicology in research and medical education; 2, 3, 8.

THOMPSON, W. JOSEPH, Professor of Pharmacology and Director, Graduate Studies, University of South Alabama College of Medicine; 342-0206 (h), 460-6059 (o); Endocrine Pharmacology, Section I; Ph.D., University of Southern California; Human receptors, diabetes, and gastric secretion; Provide drug research and consultation; 1, 2, 3, 5, 7, 8, 9.

TILL, MARGARET, Assistant Professor, Old Dominion University; (804) 623-5388 (h), (804) 440-4361 (o); Mammalian Physiology, Section I; Ph.D., Auburn University; Adrenocortical normal function and response to stress; 2, 3, 4-5-B, 5, 6, 7, 8, 9.

TIMME, STEVE L., Assistant Professor of Biology, University of North Alabama; 764-5416 (h), 760-4435 (o); Botany, Section I; Ph.D., Mississippi State University; Nine publications in bryotaxonomy; 1, 9.

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WARD, EDWARD R., Associate Professor of Microbiology, Alabama A&M University; 859-1790 (h), 859-7268 (o); Microbiology, Section I; Ph.D.; Fungal cell wall antigens as potential vaccines; Provide assistance in understanding and prevention of infectious diseases endemic to Alabama; 1, 2, 3, 4-5-A-B, 7.

WHITLOCK, SUZANNE A., Associate Professor of Biology, Fort Valley State College; (912) 825-7213 (h), (912) 825-6242; Zoology (Parasitology), Section I; Ph.D., Auburn University; The biology of Eimeria roperi; 1, 8, 9.

WILKES, JAMES C., Professor Emeritus of Biology, Troy State University; 566-2087 (h); Biology, Section I; Ph.D., University of Alabama; "Fishens of Tishomingo State Park, Tishomingo County, Mississippi," "A Check List of the Mosses in Alabama" and "Some Mosses From Mississippi;" Provide organizational work involving scientific endeavors; 1, 2, 3, 4-10-A-B, 5, 8, 9.

WILLIAMS, ANN H., Associate Professor of Zoology, Auburn University; 821-5844 (h), 826-5145 (o); Marine Benthic Ecology, Section I; Ph.D., University of North Carolina (Chapel Hill); "An Analysis of Competition in a Patchy Back Reef Environment" & "Predation by Blue Crabs Within Marshes;" Provide ecological advice and analysis for the state and private sectors; 1, 4-5-A-B, 5, 7, 9.

WILLIAMS, CAROL S., Lecturer, Biology, Tuskegee University; 727-8822 (o); Cell ultrastructure and History, Section I; M.Sc., Louisiana State University; Application of cell structure in food (meat) quality analysis and effects of environmental pollutants and radiation on cell structure; 1, 2, 5, 6, 9.

WILLIAMS, LOUIS G., Professor Emeritus of Ecology, University of Alabama/Tuscaloosa; 339-1535 (h); Freshwater and Marine Ecology; Ph.D., Duke University; Aquatic science, water quality, radionuclides, and food webs; 1, 2, 3, 4-A, 9.

WIT, LAWRENCE C., Associate Professor, Auburn University; 821-9778 (h), 826-2201 (o); Physiology (Biology), Section I; Ph.D., University of Missouri; Comparative Physiology; Act as a consultant regarding questions about physiology; 1, 2, 7, 9.

WOOTEN, MARIE W., Assistant Professor, Auburn University; 887-7630 (h), 826-4850 (o); Molecular Biology, Biochemistry, Section I; Ph.D., Texas Woman's University; "Inhibition of Nitrate-Induced Toxicity on Channel Catfish by Calcium Chloride and Sodium Chloride; Provide research and teaching/training of students; 2, 3, 8, 9.

ZEIREN, STEVEN J., Assistant Professor of Cell Biology and Anatomy, University of Alabama/Birmingham; 934-4404 (o); Anatomy and Evolutionary Biology of Teleost Fishes, Section I; Ph.D., University of Chicago; "Osteology & Evolutionary Relationships of the Boarfish genus Antigonia (Teleostei; Caproidae);" 1.

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### CHEMISTRY

BARRETT, WILLIAM J., Administrative Officer, Alabama Academy of Science & Consultant, Southern Research Institute; 879-3098 (h & o); Analytical Chemistry, Section II; Ph.D., University of Florida; Numerous journal articles and unpublished contract research reports in the area of environmental and military chemistry; Provide background information and recommendations for the development of policy decisions in technological areas in my area of expertise; 1, 2, 3, 4-30-B, 5.

BROSHEER, CLINTON J. Retired; 764-1712; Chemistry, Section II; M.S., Chemical Engineering, Case Institute of Technology.

BROWN, MARY A. H., Professor, Troy State University - Dothan (Permanent), currently Visiting Professor of Physics (until June, 1988), Dickinson College; 774-4034 (h), 792-8783 (o); Physical Chemistry, Section II; Ph.D., University of Alabama/Tuscaloosa; Solution thermodynamics and science education; 2, 6, 7, 8, 9.

CAPPAS, C. E., Associate Professor of Chemistry, University of South Alabama; 460-6181 (o); Physical Chemistry, Section II; Ph.D., University of Florida; Polymerization kinetics and physical electronic properties of polymers; 1, 4-7-A-B, 5, 6, 7, 8, 9.

CHASTAIN, BEN B., Professor & Head, Department of Chemistry, Samford University; 871-3859 (h), 870-2725 (o); Physical Inorganic Chemistry, Section II; Ph.D., Columbia University; Four - and five - coordinate nickel complexes; Provide input for discussion of the role of science in education and society; 1, 2, 4-5-A, 5, 9.

COOPER, EMERSON A., Professor and Chairman, Chemistry Department, Oakwood College; 837-0386 (h), 837-1630 (o); Bio-organic Chemistry; Section II; Ph.D., Michigan State University; "Teaching Innovations in Chemistry;" Provide teaching methodology for strengthening chemical education at the secondary and post-secondary levels; 1, 4-5-A, 8, 9.

DARLING, CHARLES M., Associate Dean and Professor, School of Pharmacy, Auburn University; 749-5696 (h), 826-4740 (o); Medicinal Chemistry, Section II; Ph.D., University of Mississippi; Potential anticonvulsant agents; Help provide proper attitude toward drug use and good health habits; 2, 3, 5, 9.

DAVIS, ROBERT S., Chemistry Teacher, The Altamont School; University of Alabama/Birmingham 822-7166 (h), 879-2006 (o); Secondary Chemistry Education; M.A.E. + 30 (AA certificate); Provide perspectives on needs in science education; 1, 2, 3, 4-14-A-B (summer), 6, 8, 9.

FLSK, JAMES D., Associate Professor of Chemistry, Samford University; 942-8824 (h), 870-2455 (o); Analytical Chemistry, Section II; Ph.D., Duke University; Journal of Chromatographic Science, April, 1986; 6, 7.

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GRAY, GARY M., Assistant Professor, University of Alabama/Birmingham; 664-2509 (h), 934-4747 (o); Chemistry, Section II; Ph.D., Lehigh University; Current research interests are: NMR spectroscopic studies of transition metal complexes, polypyronuclear transition metal complexes as catalysts, and inorganic polymers; Provide expertise in many of the newly emerging high-tech areas of inorganic and materials chemistry; 2, 3, 7, 8, 9.

GWEBU, EPHRAIM T., Associate Professor, Oakwood College, Huntsville, Alabama; 830-1772 (h), 837-1630 (o); Biochemistry/Physiological Chemistry, Section II; Ph.D., Ohio State University; "Nutritional Status In Pregnancy" and "Human Platelet Function: Effect of DDT, Vitamin E, and Benzoyl Peroxide;" Provide research to determine effects of pesticides, such as DDT, on human health; 1, 2, 4-15-B, 5, 6, 7, 8, 9.

HAZLEGROVE, L. S., Professor of Chemistry, Samford University; 870-2724 (h), 879-0004 (o); Physical Chemistry, Section II; Ph.D., University of Alabama/Birmingham; Chemical education in China and immunochemistry; 1, 2, 3, 4-4-A, 6, 7, 8, 9.

ISELL, RAYMOND E., Head, Department of Chemistry and Industrial Hygiene, University of North Alabama; 383-8742 (h), 760-4474 (o); Chemistry, Section II; Ph.D., University of Alabama; Solid rocket propellants, nitrogen fertilizers, and instrumental analysis; Provide quality education for undergraduate students; 2, 4-5-A, 5, 9.

JACKSON, MARGARET E., Professor of Chemistry, University of South Alabama; 342-2184 (h), 460-6182 (o); Chemistry, Section II; Ph.D., Auburn University; Co-ordination compounds of chromium & niobium; 2, 3, 4-B, 5, 6, 7, 8, 9.

JOTANI, KISHOR P., Assistant Professor of Chemistry, Talladega College; 761-1347 (h), 362-0206 (o); Organic Chemistry, Section II; Ph.D., Saurashtra University, India; "Synthesis and Optical Resolution of (+) - Arylamino - p - Chlorophenylacetic Acids;" Try to bring higher education in chemistry to a broad public by educational activity; 1, 2, 3, 4-summer, 5, 6, 7.

KENDRICK, AARON B., Associate Professor of Medicine (retired), College of Medicine, University of Illinois/Chicago; 477-6927 (h); Biochemistry, Section II; Ph.D., University of Chicago; past research interests are in the area of purine metabolism.

KIELY, DONALD E., Professor of Chemistry, University of Alabama/Birmingham; 934-4747 (h); Organic Chemistry, Section II; Ph.D., University of Connecticut; Research areas are fundamental carbohydrate chemistry, carbohydrate conformational analysis, and synthetic carbohydrate polymers.

KISPERT, LOWELL, Research Professor of Chemistry, University of Alabama/Tuscaloosa; 556-6678 (h), 348-7134 (o); Solid - State Chemistry, Radiation Chemistry and Magnetic Resonance, Section II; Ph.D., Michigan State University; Electron Spin Double Resonance Spectroscopy (John Wiley).

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KURZIUS, SHELBY C., Senior Staff Scientist, Lockheed Missile & Space Company; 883-8260 (h), 837-1800 (o); Chemical Engineering, Section II; Ph.D., Princeton University; "Kinetics of the Branching Step in the  $H_2/D_2 - O_2$  Reaction" and "High Temperature Fast Flow Reactor (HFFFR);" Provide scientific expertise in combustion electro-optic, missile systems, laser systems, and scientific spacecraft payload development; 2.

LAMBERT, JAMES L., Professor of Chemistry, Spring Hill College; 460-2002 (h), 460-2288 (o); Organic and Analytical Chemistry, Section II; Ph.D., Johns Hopkins University; 1, 2, 9.

LEGG, J. IVAN, Dean, College of Science & Mathematics, Auburn University; 745-7182 (h), 826-4269 (o); Chemistry, Section II; Ph.D., University of Michigan; Metal ions as probes of biological structure-function relationships; Provide significant experience in developing excellence in a university; 1, 2, 3, 8, 9.

LUDWICK, ADRIANE G., Professor of Chemistry, Tuskegee University; 821-1961 (h), 727-8836 (o); Physical Organic Chemistry and Polymer Chemistry, Section II; Ph.D., University of Illinois; Poly Nucleotide Analogs; Assist in the incorporation of polymer science into curricula at various levels (elementary to post-secondary); 1, 8, 9.

MAHAFFEY, CHRIS, Professor of Chemistry, Auburn University/Montgomery; 271-9334 (o); Chemistry, Section II; Ph.D., University of Strathclyde, Scotland; Articles in Journal of Organometallic Chemistry; 1, 2, 3, 4-2-A-B, 5, 9.

MEEHAN, EDWARD J., Associate Professor of Chemistry, University of Alabama/Huntsville; 859-6076 (h), 895-6188 (o); Chemistry, Section II; Ph.D., University of Alabama/Birmingham; Protein Crystal Growth; Provide interaction with NASA and aerospace companies involved in protein crystal growth in space; 1, 2, 3, 7, 9.

MOELLER, MICHAEL B., Professor of Chemistry, University of North Alabama; 767-7827 (h), 760-4479 (o); Physical Chemistry, Section II; Ph.D., University of Pennsylvania; Cellulose Hydrolysis: investigation of reaction kinetics by weight loss; Provide research on cellulose hydrolysis chemistry and computer modeling of physico-chemical systems; 1, 2, 6.

MURRAY, THOMAS P., Professor of Chemistry, University of North Alabama; 766-8654 (h), 760-4227 (o); Organic Chemistry, Section II; Ph.D., Virginia Polytechnic Institute and State University; "Reactions of Molten Urea With Formaldehyde" and "Synthesis of  $^{15}N$ -Labelled Urea;" Provide problem solving expertise in urea-formaldehyde resin chemistry to industry within the state; 1, 2, 3, 4-5-A-B, 5, 6, 7.

POORE, R. EARL, Professor of Chemistry; 435-3310 (h), 231-5781 (o); Biochemistry, Section II; Ph.D., Vanderbilt University; "Parathion Metabolism In Vivo" & "Parathion Metabolism in the Liver In Vivo;" Consultant in science education, organophosphate insecticides, and nutrition; 1, 2, 3, 4-5-A-B, 5, 8, 9.

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RAWLINGS, J., Associate Professor of Physical Sciences, Auburn University/Montgomery; 271-9336 (o); Biochemistry, Section II; Ph.D., Caltech; "Substrate Specificity of Creatine Kinase" and "Nitrogenase: Prosthetic Groups;" Provide expertise in biochemical or instrumental methods; 2, 3, 4-5-A-B, 5, 6, 7.

RILEY, THOMAS N., Head, Department of Pharmacal Sciences, Auburn University; 821-1924 (h), 826-4037 (o); Medicinal Chemistry, Section II; Ph.D., University of Minnesota; Medicinal Chemistry of CNS drugs published in The Journal of Medicinal Chemistry; 1, 2, 3, 4-A-B-, 5, 7, 8, 9.

SMALL, ROBERT, Research Director, Wesley Industries, Inc.; 675-9742 (h), 626-2041 (o); Organic Chemistry, Section II; Ph.D., University of Arizona; Industrial Process Development; Provide chemical information for industry; 1, 2, 3, 4-5-B, 5, 8, 9.

THOMAS, JOSEPH C., Dean of Faculty and Instruction, University of North Alabama; 764-7896 (h), 760-4258 (o); Science Education and Chemistry, Sections II and VII; Ph.D., University of Kentucky; Development of Programs for Preparation of Science Teachers at All Levels; Provide development of educational programs in science; 1, 2, 3, 4-3-A-B, 9.

WARD, E. H., Chairman, Physical Science Department, Troy State University; 566-2076 (h), 566-3000 (o); Chemistry, Section II; Ph.D., University of Mississippi; Provide scientific training of the work force; 1, 2, 4-4-A-B, 9.

WATKINS, CHARLES L., Professor of Chemistry, University of Alabama/Birmingham; 934-4747 (o); Chemistry, Section II; NMR Spectroscopy and New Inorganic Compounds for Materials Science Applications; Provide preparation and characterization of new materials for electronics and other applications; 2, 9.

WHEELER, GLYNN P., Southern Research Institute (retired); 879-3023 (h); Chemistry, Section II; Ph.D., Vanderbilt University; Numerous publications related to experimental cancer chemotherapy.

WHITT, CARLTON D., Retired Industrial Chemist and College Teacher; 233-3873 (h); Chemistry, Section II; Ph.D., University of Alabama; "Vapor Pressure of Phosphoric Acids," "Some Reactions of Phosphate with Clasp and Hydrous Oxides of Iron and Aluminum," "The Crystal Structure of Trimethyl (Quinuclidine) Aluminum," and "The Structure of Dimethylbis (Quinuclidine) Beryllium;" 2, 3, 8, 9.

## GEOLOGY

BRANDE, SCOTT, Associate Professor of Geology, University of Alabama/Birmingham; 823-7648 (h), 934-2439 (o); Paleontology, Geostatistics, Section III; Ph.D., SUNY, Stony Brook; "Marine Geology of Mobile Bay" and "Statistics for Geoscientists;" Provide science education; 1, 2, 4-3-B, 5, 9.



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BURNHAM, DAVID A., Research Assistant, University of New Orleans; (504) 469-2347 (h), (504) 286-6591 (o); Geology, Section III; B.S., Geology, University of New Orleans; currently completing M.S. thesis research on Alabama mosasaurs; 1, 2, 3, 6, 7, 8, 9.

CRANFORD, NORMAN BAYNE, Auburn University (alumnus); 887-3339 (h); Geology, Section III; M.A., Midwestern State University; Have the ability to interpret and lecture upon mineral and fuel history of Alabama; 1, 2, 3, 4-30-B, 6, 8, 9.

CROSS, WHITMAN, II., Executive Director, Red Mountain Museum; 879-1350 (h), 933-4152 (o); Geology, Section III; Ed.D., Temple University; Ground water resources in Piedmont crystalline and surficial geology of Essex Quad, CT.; Can present the geologic and paleontologic heritage of Alabama to the public (and professional earth scientists) through education and exhibits; 1, 3, 5, 8, 9.

DEAN, LEWIS S., Geologist, Geological Survey of Alabama; 553-1005 (h), 349-2852 (o); Geology and Mineral Resources, Section III; M.S., Emory University; "Minerals in Alabama, 1986;" Provide geologic and mineral resource studies for distribution by the Geological Survey of Alabama; 1, 2, 7, 8, 9.

DERSTLER, KRAIG, Assistant Professor, Department of Geology and Geophysics, University of New Orleans; (504) 286-6799 (o); Paleontology, Section III; Ph.D., University of California/Davis; "Estimating Morphological Rates of Evolution;" Improve understanding of Upper Cretaceous vertebrate fauna and its evolution; 1, 2, 3, 8, 9.

ESPOSITO, RICHARD, Geologist 1, Alabama Department of Environmental Management; 826-6400 (h), 271-7976 (o); Geology, Section III; M.S.; 1, 7.

GASTALDO, ROBERT A., Associate Professor, Auburn University; 821-6982 (h), 826-4282 (o); Paleobiology, Geology, Section III; Ph.D., Southern Illinois University/Carbondale; Carboniferous paleoecology of Euramerican Province and phytotaphonomy of hydrocarbon accumulating deltaic regimes; Provide evaluation of depositional environments in hydrocarbon producing strata; 2, 3, 5, 7, 8, 9.

GROSHONG, RICHARD H., Jr., University of Alabama/Tuscaloosa; 333-8326 (h), 348-1882 (o); Geology, Section III; Ph.D., Brown University.

KING, DAVID T., Jr., Associate Professor of Geology, Auburn University; 826-4282 (o); Geology, Section III; Ph.D., University of Missouri; "Coastal Plain Chalks" and "Paleozoic Limestones;" Provide geological consulting; 2.

LAMB, GEORGE M., Professor of Geology, University of South Alabama; 344-0030 (h), 460-6381 (o); Geology, Section III; Ph.D., University of Colorado; Coastal changes in Alabama; Provide studies of erosion, deposition, and ground - water movement and pollution; 1, 2, 3, 4-10-A-B, 5, 6, 7, 8, 9.

## Directory of the Alabama Academy of Science

LAMOREAUX, PHILIP E., Chairman of the Board, P.E. LaMoreaux & Associates, Inc., 752-5543 (h), 758-8930 (o); Geology, Section III; Honorary doctorate, Denison University; "Catastrophic Subsidence: An Environmental Hazard, Shelby County, Alabama;" 45 years experience with U.S. Geological Survey and Alabama Geological Survey; 1, 2, 3, 4-6-A-B, 5, 8, 9.

OWENS, DARYL, Technical Writer, Scitek, Inc.; 852-4893 (h), 830-9700 (o); Geology, Section III; B.A., University of Alabama/Huntsville; The use of remote sensing in predicting coal mine roof falls; Provide technically and grammatically sound documentation (in my research area) for the state and industry; 4-10-A-B, 5.

PATERSON, DANIEL J., Doctoral Candidate, University of Alabama/Tuscaloosa; 349-1406 (h), 348-5095 (o); Geology, Section III; M.S., University of Missouri/Columbia; Doctoral thesis research is on the structural geology of the Birmingham anticlinorium in the Appalachian fold and thrust belt in North Central Alabama.

RHEAMS, KAREN F., Geologist, Mineral Resources Division, Geological Survey of Alabama; 556-5242 (h), 349-2852 (o); Geology, Section III; M.S., University of Alabama/Tuscaloosa; "Characterization and Geochemistry of Devonian Oil Shale: North Alabama, Northwest Georgia, and South Central Tennessee (A Resource Evaluation)," and "Bibliography of Alabama Piedmont Geology with Selected Annotations," and "Mineral Resources of Chilton County, Alabama;" 1, 2, 8, 9.

SHULTZ, ALBERT W., Assistant Professor, Department of Geology, University of Alabama/Tuscaloosa; 556-8613 (h), 348-1884 (o); Geology, Section III; Ph.D., Indiana University; Ancient alluvial sediments in Colorado and sandstone hardbottoms of Northeastern Gulf of Mexico; 7, 8, 9.

STOCK, CARL W., Associate Professor of Geology, University of Alabama/Tuscaloosa; 553-8732 (h), 348-1883 (o); Paleontology, Section III; Ph.D., University of North Carolina; Devonian stromatoporoids of Iowa and New York and Silurian stromatoporoids of Virginia and New York; 1, 7.

THURN, RICHARD L., Assistant Professor of Geology, Livingston University; 652-2939 (h), 652-9661 (o); Geology and Science Education, Sections III and VII; Ed.S., University of Iowa; Interest and experience in earth science education and geology - petroleum exploration; 1, 2, 3, 4-4-A-B, 5, 6, 8.

### FORESTRY, GEOGRAPHY, CONSERVATION AND PLANNING

BOYER, WILLIAM D., Research Forester, USDA, Forest Service, Southern Forest Experiment Station; 821-3932 (h), 826-8700 (o); Forestry (Ecology), Section IV; Ph.D., Duke University; Numerous articles on silviculture of Southern pine; Provide guidance on regeneration and management of Southern pine forest low - cost prescriptions applicable to small non industrial private forest landowners; 2, 4-10-A-B, 5, 8.

## Directory of the Alabama Academy of Science

DEVAL, WILBUR B., Professor Emeritus, Forestry, Auburn University; 887-8180 (h), 826-4050 (o); Forestry, Section IV; M.S., University of Florida; Forestry problems in Alabama; Serve in an advisory capacity in the areas of university teaching, research, administration, and small business development; 2, 3, 4, 9.

GIBBS, GEORGE S., USDA, Forest Service (retired); 263-2264 (h); Wildlife Management and Forestry, Section IV; B.S., North Carolina State University.

RIVIZZIGNO, VICTORIA, Associate Professor, Geography, University of South Alabama; 343-5466 (h), 460-6381 (o); Economic Geography, Section IV; Ph.D., Ohio State University; "County Business Patterns For Alabama" and "Alabama's Service Industries: 1974-1983;" Provide a spatial analysis of demographic and economic data for private industry and government agencies; 2, 5, 7.

STRONG, WILLIAM R., Professor of Geography, University of North Alabama; 757-4516 (h), 760-4218 (o); Geography, Section IV; Ph.D., University of Texas/Austin; Shoals Industrial Development Information Systems - CIS; Provide geographic information systems research for land use analysis and for urban/regional planning; 1, 2, 9.

TANG, R. C., Professor, School of Forestry, Auburn University/Auburn; 887-6084 (h), 826-4216 (o); Wood Science, Applied Mechanics and Structural Engineering, Section IV; Ph.D., North Carolina State University; Mechanics and physics of wood composite systems, modeling, and simulation (numerous publications); 1, 2, 3, 7, 9.

WEAVER, DAVID C., Chairman and Professor of Geography and Director, Regional and Urban Planning Program, University of Alabama/Tuscaloosa; 348-5047 (h), 339-9911 (o); Geography, Section IV; Ph.D., University of Florida; Tenn-Tom country and Alabama land use; Provide land use analysis and urban/regional planning; 2, 3, 7, 9.

### PHYSICS AND MATHEMATICS

AGGARWAL, MANMOHAN D., Associate Professor of Physics, Alabama A&M University; 883-7691 (h), 859-7470 (o); Physics, Section V; Ph.D., Calcutta University; Crystal growth from solution and from melt and fabrication and characterization of solid state devices; Provide technical know - how to grow a variety of crystals for high-tech applications; 1, 4, 5, 6, 7, 8, 9.

ALEXANDER, DON, Associate Professor of Mathematics, University of Montevallo; 665-5239 (h), 665-6486 (o); Topology/Analysis and Mathematics Education, Section V; Ph.D., University of Alabama/Tuscaloosa; "Writing reinforcement in Mathematics" and "Writing In The Mathematics Class;" Provide to post-secondary educators examples and rationale for required, graded writing assignments in all disciplines; 1, 3, 9.

## Directory of the Alabama Academy of Science

ALFORD, WILLIAM L., Associate Dean for Research, Director of the Nuclear Science Center, and Professor, Auburn University; 887-7351 (h), 826-4230 (o); Nuclear Physics, Section V; Ph.D., California Institute of Technology; Research on neutron induced reactions and on radioactive nuclei; Conduct studies relative to the applications of atomic and nuclear physics; 1, 4-3-A, 7.

BEARDEN, THOMAS E., Senior Scientist, Computer Sciences Corporation; 533-3682 (h), 837-7200 (o); Nuclear Engineering, Section V; M.S., Nuclear Engineering, Georgia Institute of Technology; AIDS: SOVIET FIRST STRIKE, AND THE NEW SCIENCE THAT CAN STOP MAN'S GREATEST THREAT and "Maxwell's Lost Unified Field Theory;" I expect to be able to assist in bringing to market working model antigravity devices and "vacuum energy" devices in the near future.

BEIERDORFER, PETER, Graduate Student, Princeton University; (609) 683-1929 (h), (609) 243-2722 (o); Plasma and Atomic Physics, Section V; M.S., Auburn University; X-ray spectroscopy of highly charged ions and charge-exchange measurements on tokamaks; 1, 5.

CHRISTENSEN, CHARLES R., Research Physicist, U.S. Army Missile Command; 232-5966 (h), 876-3934 (o); Optics, Section V; Ph.D., California Institute of Technology; 30 publications and 5 patents in coherent optics and magnetic resonance spectroscopy; 1.

COMFORT, RICHARD H., University of Alabama/Huntsville; 881-1950 (h), 895-6404 (o); Physics, Section V; Ph.D., University of Alabama/Huntsville; Space plasma physics; Act as a resource on space environmental questions for agencies/firms; 1, 2, 5, 7, 8.

ESSENWANGER, OSGAR K., Supervisor of Research & Physicist, U.S. Army Missile Command and Adjunct Professor of Environmental Science, University of Alabama/Huntsville; 881-5091 (h), 876-4872 (o); Climatology and Environmental Science, Sections V & IV; Ph.D., Wurzburg, FRG; Elements of Statistical Analysis and Applied Research in Atmospheric Science; 1, 3, 8.

FURMAN, W. L., S. J., St. Joseph's Church, Mobile, AL; 432-4218 (h); Physics and Mathematics, Section V; Ph.D., University of Florida/Gainesville.

GALLAGHER, DENNIS L., Research Scientist, NASA, Marshall Space Flight Center; 881-7491 (h), 544-7587 (o); Magnetospheric Physics, Section V; Ph.D., University of Iowa; "Short Wavelength Electrostatic Waves in the Earth's Magnetosheath;" Increase state's visibility nationally and internationally, attract students to our state's universities, and work with students in space plasma physics research; 1, 2, 3, 8, 9.

HARRISON, JOSEPH G., Assistant Professor of Physics, University of Alabama/Birmingham; 988-4043 (h), 934-1559 (o); Solid State Physics, Section V; Ph.D., University of Wisconsin; "Electron Affinities in the Self-Interaction-Corrected Local Spin Density Approximation;" Help provide a research program in theoretical physics as a base for R&D programs; 1, 2, 3, 4-5-A, 7, 8, 9.

HAWK, JAMES F., Lecturer in Physics, University of Alabama/Birmingham; 967-1135 (h), 934-8088 (o); Physics, Section V; A. M., Washington University; optics research; Provide consultation in the general field of physics with primary emphasis on optics; 1, 2, 3, 4-7-A-B, 7, 8, 9.

HUDSON, GLENN, Branch Chief, Tennessee Valley Authority, Office of Nuclear Power, Chattanooga, Tennessee; (615) 877-5760 (h), (615) 751-3075 (o); Physics, Section V; Ph.D., Auburn University; "The Need for Dosimetry Multibadging at Nuclear Power Plants;" 1, 2, 3, 4-3-A-B, 5, 8, 9.

JONES, STANLEY T., Professor of Physics, University of Alabama/Tuscaloosa; 758-0359 (h), 348-3797 (o); High Energy Physics Theory, Section V; Ph.D., University of Illinois; "QCD Corrections to B Decay;" Provide advice regarding significance of high energy physics (e.g., the super collider); 1, 2, 3, 4-5-A-B, 5, 8, 9.

LEITNER, BARBARA J., Assistant Professor, University of Montevallo; 823-7648 (h), 665-6462 (o); Earth Science and Geophysics, Section V; M.Sc., SUNY, Stony Brook; Earthquake hazard studies, small earthquakes, and after-shock studies. Study of behavior of rocks in earth's mantle; Improve growth and personal safety through general science education; 2, 4-4-B, 8, 9.

LESTER, WILLIAM L., Provost and Associate Professor of Mathematics, Tuskegee University; 727-4912 (h), 727-8164 (o); Mathematics and Statistics, Section V; Ph.D., Southern Methodist University; 3, 9.

MIYAGAWA, ICHIRO, University Research Professor of Physics, University of Alabama/Tuscaloosa; 752-9880 (h), 348-3787 (o); Solid State Physics, Section V; D.Sc., University of Tokyo; Research in electron spin resonance study of irradiated crystals; 7.

RASH, CLARENCE E., Physicist, U.S. Army Aeromedical Research Lab; 347-5487 (h), 255-6814 (o); Physics, Section V; M.S., Old Dominion University; Electro-optical imaging; 2, 9.

REISIG, GERHARD H.R., Adjunct Professor of Physics, Tri-College University and Associate Professor of Cybernetics (emeritus), University of Tennessee Space Institute; Engineering Physics, Sections V & X; Information systems concepts in data analysis (space systems analysis); 1, 2, 3.

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SHEALY, DAVID L., Professor and Chair, Department of Physics, University of Alabama/Birmingham; 967-9175 (h), 934-8068 (o); Physics, Section V; Ph.D., University of Georgia; Optics of laser and X-ray optical systems, Materials for microelectronic packaging applications; Provide application of physics in high technology areas; 1, 2, 5, 7.

SMITH, MICKY, Assistant Professor of Mathematics, Livingston University; 652-7459 (h), 652-9661 (o); Mathematics, Section V; M.A.; 1, 2.

SMOOT, HENRENE E., Professor of Mathematics, Alabama A&M University; 536-5241 (h), 859-7448 (o); Mathematics, Section V; D.Sc., Southeastern Institution of Technology; "Semantic - Diagrammatic Materials for the Improvement of Problem-Solving Skills;" Provide advice on the teaching of mathematics; 1, 2, 4-2-A.

SNYDER, ROBERT S., Chief, Biophysics Branch, Marshall Space Flight Center; 539-3304 (h), 544-7805 (o); Physics, Section V; D.Sc., University of Virginia; Space research; 8, 9.

SPENCER, GILBERT O., Troy State University/Troy (retired); 852-1749 (o); Physics, Section V; M.A., Peabody College; 1, 8.

TURNER, MALCOLM E., Professor of Biostatistics and Biomathematics, University of Alabama/Birmingham; 988-0451 (h), 934-4905 (o); Mathematical Biology, Section V; Ph.D., North Carolina State University; Numerous publications on theory and applications of mathematics and statistics to problems in biology; Provide consultation in scientific and mathematical education; 1, 2, 3, 4-20-A-B, 5, 7, 9.

VARGHESE, S. L., Professor of Physics, University of South Alabama; 666-4529 (h), 460-6224 (o); Physics, Section V; Ph.D., Yale University; "First Excited State of Positronium," "Pico Second Lifetimes," and "Accelerator Based Atomic Physics Including Those With LEHQ Ions;" Provide productive research in pure and applied physics; 1, 2, 3, 4-3-A-B, 5, 6, 7, 8, 9.

### INDUSTRY AND ECONOMICS

ALEXANDER, JAMES G., Associate Professor of Economics, Alabama A&M University; Economics, Section VI; ABD, University of Texas/Austin; "The Poultry Industry - TARCOG Areas," and "Reaganomics and Reaganism;" Provide counsel on public policy issues; 1, 2, 5, 6, 7, 8, 9.

BRYAN, ALBERT H., JR., Vice President, Raytheon Company, Huntsville, Alabama; 534-3774 (h), 533-6637 (o); Industry, Section VI; Sc.M., Massachusetts Institute of Technology; "A Study of Nuclear Effects ..." (Classified); Provide technical and general management of complex systems, Department of Defense; 1, 2, 3, 9.

Directory of the Alabama Academy of Science

**BUSBIN, JAMES W.**, Assistant Professor, University of Alabama/Huntsville; 534-5885 (h), 895-6680 (o); Marketing, Section VI; Ph.D., University of Tennessee; Numerous publications in marketing management and consumer behavior; Skilled market researcher and analyst; 2, 3, 7, 9.

**CASE, JAN O.**, Samford University; 744-5553 (h), 870-2453 (o); Educational Statistics, Section VI; Ed.D., Mississippi State University; 5, 8.

**CHASTAIN, E. D.**, Professor of Economics, Auburn University; 887-5737 (h), 826-5719 (o); Economics, Section VI; Ph.D., Purdue University; Systems analysis applied to macroeconomics; Provide perspectives on economic development; 1, 2, 3, 9.

**ENGLE, CAROLE R.**, Assistant Professor of Economics, Auburn University/Montgomery; 826-6017 (h), 271-9561 (o); Aquacultural Economics, Section VI; Ph.D., Auburn University; "Optimal Product mix for Integrated Livestock-Fish Culture Systems on Limited-Resource Farms" and "Economic Analysis of Aquaculture as a Component of Integrated Agro-Aquaculture Systems: Some Evidence from Panama;" Provide economic and market analysis to catfish farmers; 1, 2, 3, 5, 7, 9.

**GENILE, EDGAR C., JR.**, P.E.; 991-7878 (h & o); B. S., Auburn University/Auburn; Electrical Engineering, Section VI; Data communications in business; Provide a knowledge of systems, particularly telecommunications; 1, 2, 3, 4-5-A, 5, 6, 7, 8, 9.

**GIBSON, DENNIS W.**, Associate Professor, Troy State University/Montgomery; 279-9617 (h), 241-9603 (o); Human Resource Management, Section VI; Doctoral candidate, University of Alabama/Tuscaloosa; Leadership, human capital, and labor relations; 1, 2, 3, 4-5-B, 7, 8, 9.

**GREGOROWICZ, PHILIP**, Associate Professor of Economics, Auburn University/Montgomery; 277-6927 (h), 271-9515 (o); Economic Analysis, Section VI; Ph.D., Northern Illinois University; International economics, exchange rates, financial markets, expert witness, and economic consultant; "Deficit Financing Announcements and Asset Prices;" 1, 2, 3, 5, 7, 9.

**GRIFFIN, MARSHA D.**, Associate Professor of Marketing, Alabama A&M University; 883-7209 (h), 859-2771 (o); Marketing, Section VI; DBA, Louisiana Tech University; "Marketing: The New Priority in Huntsville, Alabama" and "A Survey of the Poultry Industry in Alabama;" Provide research on marketing issues facing Alabama; 5, 6, 7, 8, 9.

**HAYNES, JAMES F.**, Associate Professor of Economics, Athens State College; 881-0362 (h), 232-1802 (o); Economic Education, Section VI; Ph.D., Vanderbilt University; "Economic Knowledge and Attitudes Toward Economic Issues;" Provide assistance to small business owners in the area of economic and financial matters; 2, 3, 9.

HEACOCK, MARIAN V., Professor, Department of Management, University of Alabama/Birmingham; 879-5852 (h), 934-8840 (o); Business and Society and Business Ethics, Section VI; Ph.D., University of Alabama; Churning, an ethical issue in finance and whistle blowing, an issue in ethical organizational behavior; 1, 2, 3, 4-A-B, 5, 6, 7, 9.

HEGJI, CHARLES E., Assistant Professor of Economics, Auburn University/Montgomery; Economics, Section VI; Ph.D., Washington University/St. Louis; Numerous articles in monetary economics; Provide a thorough understanding of money and market reactions to money; 1, 2, 3, 4-12-A-B, 5, 6, 7, 8, 9.

JOHNSON, RAYMOND M., Associate Professor, Auburn University/Montgomery; 567-7065 (h), 271-9493 (o); Finance, Section VI; Ph.D., Oklahoma State University; Duration analysis; Provide financial analysis; 2, 3, 4-A-B, 5, 6, 7, 8.

KAMNIKAR, JUDITH A., Associate Professor and Head, Department of Accounting and Finance, Auburn University/Montgomery; 277-8245 (h), 271-9496 (o); Accounting & Finance, Section VI; Ph.D., University of Denver; Governmental and NFP accounting/financial reporting; 4-12-A.

IACY, A. WAYNE., Professor and Head, Department of Economics, Auburn University/Montgomery; 271-9511 (o); Economics, Section VI; Ph.D., Iowa State University; Published research in the economics of public utilities (electrical), demographic economics, and current state of the nation and Alabama; Provide economic impact studies; 1, 2, 3, 5, 7, 9.

LONGENECKER, HERBERT E., Associate Professor, Computer and Information Sciences; University of South Alabama; 342-4674 (h), 460-6390 (o); Computer information systems, Sections VI & X; Provide assistance with computers and information systems; 1, 2, 4-2-A.

LORTIE, JOHN W., Director of Research, Energy Research Corporation, Mobile, Alabama; 342-5868 (o); Industry, Section VI; "High Energy Yield: Advances In Energy Technology;" Have extensive trade partners in Middle East countries. Currently working on solar applications to dehydrate commercial waste; 2, 3, 7, 9.

LOVIK, LAWRENCE W., Adams-Bibb Chair of Free Enterprise and Director of Center for Economic Education and Professor of Economics, Troy State University/Troy; Economic Analysis, Section VI; Ph.D., Georgia State University; "Enterprise and Freedom" and "Economic Development of Alabama;" Provide economic analysis and consequent policy implications; 2, 3, 5, 8, 9.

LUNDQUIST, CHARLES A., Director of Research, University of Alabama/Huntsville; 883-8926 (h), 895-6620 (o); Space science, Section VI; Ph.D., University of Kansas; Skylab's Astronomy and Space Sciences; Provide commercial development of space; 1, 2, 3, 7.



Directory of the Alabama Academy of Science

MOBERLY, H. DEAN, Professor of Economics and Graduate Coordinator, School of Business, Auburn University/Montgomery; 272-8460 (h), 271-9523 (o); Applied Economic Analysis, Section VI; Ph.D., Texas A&M University; "The Escalating Costs of U.S. Health Care" and "Medicaid Spending Patterns in Alabama;" Provide economic analysis of resource use for the State, business firms, and households; 1, 2, 4-5-A, 5, 8, 9.

NORRELL, FRED M., Economist, Alabama Power Company, Birmingham; 250-4405 (o); Applied Economic Analysis, Section VI; M.A., University of Alabama/Tuscaloosa; Improve electric utility resource allocation and service.

RAWLINS, V. LANE, Vice Chancellor, University of Alabama System, Professor of Economics, University of Alabama/Tuscaloosa; 556-6659 (h), 348-8347 (o); Economics, Section VI; Ph.D., University of California/Berkeley; Two books and several articles in labor economics; Provide a better understanding of higher education and labor market needs; 2, 4-B, 5, 9.

SAUSER, WILLIAM I., JR., Associate Vice President For Extension, Auburn University; 277-1674 (h), 826-4444 (o); Industrial/Organizational Psychology, Section VI; Ph.D., Georgia Institute of Technology; "Sex Differences In Job Satisfaction: A Re-Examination" and "Labor Relations In Alabama Local Government;" Provide consultation in areas of human resource management; 1, 2, 3, 7, 9.

STALLINGS, JAMES L., Associate Professor, Agricultural Economics, Auburn University/Auburn; 821-1449 (h), 826-4803 (o); Business and Industry, Section VI; Ph.D., Michigan State University; 2, 3, 4-5-A-B, 5, 7, 9.

STEWART, G. T., Professor of Economics, Troy State University/Troy; 566-0682 (h), 566-3000 (o); Economic Theory, Section VI; Ph.D., University of Alabama/Tuscaloosa; Instability in Public and Private Demand; Provide economic analysis of resource use; 4-3-A-B, 5, 6, 7, 9.

SULZBY, JAMES F., President, Sulzby Realty Company, Incorporated, Birmingham; 324-0998 (h), 322-1829 (o); Industry and Economics, Section VI; A.B., Birmingham - Southern College; History of Samford University plus numerous publications on the history of Alabama; Promote interest in Alabama: Past and Present.

WILLHARDT, JOHN A., Chairperson, Department of Computer Information Systems, Alabama State University; 284-1924 (h), 293-4125 (o); Computer Information and Administration, Section VI; Ph.D., University of Iowa; Collegiate computer curriculum for systems analysis; 1, 2, 3, 7, 9.

YEAGER, JOSEPH H., Head, Department of Agricultural Economics and Rural Sociology, Auburn University/Auburn; 887-8010 (h), 826-4800 (o); Agricultural Economics, Section VI; Ph.D., Purdue University; Housing needs, financing, credit, farm business, economics, and Alabama agriculture; Work with Alabama Resource Development Committee to keep leaders in government, education, and industry aware of developments underway and needed as well as opportunities in agribusiness development; 1, 2, 3.

SCIENCE EDUCATION

BAIRD, WILLIAM E., Assistant Professor, Science Education Auburn University/Auburn; 821-4448 (h), 826-4434 (o); Science and Computer Education, Section VII; Ph.D., University of Texas/Austin; Microcomputer - enhanced learning and science process skills, teacher training; Provide improved effectiveness of microcomputers in pre-college education, with teacher training; 1, 3, 4-3-A, 8, 9.

BALL, PATSY, Science Chairman, Jackson Academy; (601) 268-1275; Microbiology, Chemistry, Section VII; B.S., Post graduate work, USM; 2, 6, 7, 8.

CAUDLE, SANDRA I., Manager, Browns Ferry Visitor Center, Browns Ferry Nuclear Plant, TVA; 232-0709 (h), 729-3496 (o); Biological Sciences, Section VII; M.A.C.T., Western Kentucky University; Provide special programs for various groups, schools, community college in a variety of fields (nuclear energy to environmental education) at the Browns Ferry Visitor Center (also provide outreach speakers); 1, 2, 8, 9.

CLEMENTS, BEN A., Associate Dean, Jefferson State Junior College/Birmingham; 631-4544 (h), 853-1200 (o); Science Education, Section VII; Ed.D., Auburn University/Auburn; Provide experience in effective science teaching; 1, 9.

GONCE, MARY NELL, Chairman, Science Department, Bradshaw High School, Florence, Alabama; 764-3198 (h), 764-8821 (o); Chemistry and Science Education, Section VII; M.A., University of North Alabama; 8, 9.

HAYES, ROBERT E., Science Teacher, Tallassee High School; 279-9796 (h), 283-2187 (o); Science Education, Section VII; Ed.S., Auburn University/Montgomery; "An Analysis of Cueing In Response Elicitation," "CCAF - A Lesson In Space Age Curriculum Development," and "A Super Model For Teaching Physics;" Provide guidance on science fairs and lab procedure; assist in upgrading science education; 1, 2, 3, 4-2-B, 6, 7, 8.

MAHRY, HELEN M., High School Teacher (retired); 592-6404 (h); History, Anthropology, and Social Science, Section VII; M.A., University of Alabama/Tuscaloosa; Presently working on Birmingham history; Help preserve Alabama history and historical entities; 1, 8, 9.

MEREB, TAMRAT, Assistant Professor of Communication, Alabama State University; 284-2942 (h), 293-4493/240-6855 (o); Instructional Technology and Communication Arts, Section VII; Ph.D., University of Wisconsin/Madison; "Mass Media and Society: A Case Study of the Impact of Radio/Television and the Electronic Media On The Social, Cultural, Political, and Economic Spheres of Societal Life;" Provide media information on mass communications and change, communications for rural development and effects of mass communications; 1, 4, 5, 6, 9.

## Directory of the Alabama Academy of Science

NALL, JANE D., Teacher, Escambia County High School; 368-2826 (h), 368-9181 (o); Education/Biology, Section VII; M.Ed., Livingston University; Inservice training and workshops on science fairs; 1, 6, 8, 9.

RATNEY, IARRY, Project Director, Biomedical Sciences Preparation Program, University of Alabama/Tuscaloosa; 553-7572 (h), 348-7948 (o); Secondary Education, Section VII; Ph.D., University of Alabama/Tuscaloosa; "University - Secondary Collaborative Inservice: A Model;" Provide consultant services to schools and universities for staff development, evaluate science programs, and conduct teacher workshop; 1, 2, 3, 4-2-B, 5, 9.

REYNOLDS, BARBARA S., Science Instructor, Opp High School; 492-4016 (h), 493-4561 (o); Secondary Education, Physical Sciences, Section VII; M.Ed., Auburn University/Montgomery; Newsletter Editor - Alabama Science Teachers Association; Provide educator's perspective for members of community and industry; 2, 4-5-A-B, 5, 7, 8, 9.

RIGGSBY, DUTCHIE S., Professor of Education, Columbus College; (404) 323-4154 (h), (404) 568-2250 (o); Elementary Education, Section VII; Ed.D., Auburn University; "The STS as a Resource for Middle School Science Teaching" and "Falcon Force: An Update on The Revised Edition of a Middle School Aerospace Science Program;" Provide enthusiasm for aerospace programs aimed at the elementary level and its importance to Alabama; 1, 2, 4-A-B, 5, 6, 9.

RIGGSBY, ERNEST D., Professor of Science Education and Director of Aerospace Science Programs, Columbus College; (404) 323-4154 (h), (404) 568-2255 (o); Improving the Science Education Curriculum, Section VII; "Status Report on Space Projects of The United States" and "Improving the Quality of Independent Study and Science Projects for Middle Grade and High School Students;" Provide consultation to schools and agencies (public and private) on improving science teaching; 1, 2, 4-20-A-B, 5, 8, 9.

WELKER, JAMES D., Professor of Science Education, University of Alabama/Tuscaloosa; 553-5661 (h), 348-1415 (o); Science Education, Section VII; Ed.D., Indiana University; "Utilization of Microcomputers in Teacher Education at Southeastern Colleges and Universities;" 1, 3, 4-14-A-B, 8, 9.

WHITSON, DAN, Head, Science Department, Austin High School, Decatur, Alabama; 353-0554 (h), 552-3060 (o); Biology, Chemistry, Section VII; Ed.S., University of Alabama/Birmingham; 1, 2, 3, 6, 8, 9.

### SOCIAL SCIENCES

COURSEY, DAVID H., Research Associate, Technology and Information Policy Program, The Maxwell School, Syracuse University; (315) 699-6647 (h), (315) 423-1890 (o); Artificial Intelligence, Section VIII; MPA, University of Alabama/Birmingham; Conducted experiments on decision-making with expert systems, developed three systems to date; Willing to provide assistance with expert system development, survey construction, and economic development policy; 2, 3, 4-5-A-B, 7, 9.

Directory of the Alabama Academy of Science

CRAMPTON, ROGER B., Enterprise State Junior College; 347-1619 (h), 347-2623 (o); Psychology, Section VIII; Ph.D., University of Alabama/Tuscaloosa; Psychology of gifted adolescents; 2, 3, 6, 7, 8.

HAYNES, MIKE, Mental Health Coordinator, Bullock County Correctional Facility; 271-4910 (h), 738-5625 (o); Counseling Psychology, Section VIII; M.A., Harding University & M.Ed., Auburn University/Montgomery; "The Use of Positive Reinforcement (DRO) to Reduce Aggressive Behavior in Prison;" Provide analysis of treatment programs for offenders; 1, 2, 3, 4-5-A-B, 5, 7, 9.

HOKE, DANIEL M., Clinical Director, Cahaba Center For Mental Health and Mental Retardation; 872-0029 (h), 875-2100 (o); Psychology, Section VIII; Ph.D., University of Alabama/Tuscaloosa; Interested in Wechsler scale characteristics of aggressive and non-aggressive institutionalized juveniles; 4-2-A-B, 5.

JOHNSON, JAMES A., Assistant Professor, Health Services and Public Administration, Memphis State University; (901) 452-8820 (h), (901) 454-2395 (o); Organizational Behavior, Section VIII; Ph.D., Florida State University; "Action Learning For Improved Management Performance" and "Interorganizational Network Development: Findings From Research and Practice;" 2, 3, 5, 6, 7, 9.

MCDADE, CLAUDIA E., Professor of Psychology and Director, Center For Individualized Instruction, Jacksonville State Univ.; 435-9631 (h), 231-5570 (o); Psychology, Instructional Technology, and Applied Behavior Analysis, Section VIII; Ph.D., La. State Univ.; "Precision Management of Instructional Technology: A Program Update" and "Computer-Assisted Instruction Within the Center for Individualized Instruction;" "Development of mastery-based training to provide technical skills to unskilled labor and to school age populations; 1, 2, 3, 4-10-A-B, 5, 6, 7, 9.

OSTERHOFF, WILLIAM E., Department of Justice and Public Safety, Auburn University/Montgomery; 567-6988 (h), 271-9693 (o); Justice and Public Safety, Section VIII; Ph.D., University of Alabama/Tuscaloosa; Various publications in corrections and jail management; Provide expertise in corrections and jail management and planning; 1, 2.

SMITH, KARL D., Chemistry Instructor, George C. Wallace State Community College, Selma, AL; 874-7742 (h), 875-2634 (o); Teaching Science, Section VIII; Ph.D.; 6.

VOCINO, THOMAS, Professor and Head, Department of Government, Auburn University/Montgomery; 277-4619 (h), 271-9696 (o); Political and Social Science, Section VIII; Ph.D., Southern Illinois University; Publications in major public administration journals; 1, 2.

WEBER, BERNARD C., Professor Emeritus of History, University of Alabama/Tuscaloosa; European History, Section VIII; Ph.D., Univ. of California/Berkeley; Resource person in historical investigations; 2, 3, 4-10-A, 5.

## Directory of the Alabama Academy of Science

### HEALTH SCIENCES

ADAMS, CARA, Associate Professor, University of Alabama/Birmingham; 823-4177 (h), 934-3566 (o); Physical Therapy, Section IX; M.S., Case Western University; Anatomical urinary stress incontinence; 1, 2, 8, 9.

ADDISON, MARK K., Physician/Clinical Director, Bryant Primary Care Clinic, Bryant, Alabama; 853-6394 (h), 597-2135 (o); Medicine, Health Care Organization, and Policy, Section IX; M.D., University of South Alabama (M.P.H., expected 1988, UAB); Psychopharmacology pediatrics; Advisor on rural health care organization and care delivery; 1, 2, 3, 4-A-B, 5, 7, 8, 9.

ALEXANDER, JANET G., Assistant Professor, Nursing, University of Alabama/Birmingham; 979-5433 (h), 934-6147 (o); Nursing, Section IX; M.S., UAB; "Staff Members' Ability to Recognize Common Health Problems of Children in Day Care Centers;" Assist child care providers in updating knowledge about health care needs of children in day care setting; 1, 2, 7, 9.

BARKER, PETER E., Assistant Professor, Medical Genetics, University of Alabama/Birmingham; 934-1077 (h); Genetics, Section IX; Ph.D., University of Texas/Houston; Human gene mapping; 2, 7, 8.

BARTON, JAMES C., Professor of Medicine, University of Alabama/Birmingham; 967-8543 (h), 934-3691 (o); Medical Sciences, Section IX; M.D., University of Tennessee/Memphis; Metal metabolism and metal - binding proteins; Provide basic science and clinical information on matters related to metal absorption and metabolism; 2, 3, 4-2-A, 7, 9.

BENNETT, J. CLAUDE, Professor and Chairman, Department of Medicine, University of Alabama/Birmingham; 967-0113 (h), 934-5304 (o); Internal medicine, Section IX; M.D., Harvard University; 141 publications including "The Infectious Etiology of Chronic Rheumatic Diseases."

BERGMAN, JOAN S., Professor and Director, Physical Therapy, Sparks Center, University of Alabama/Birmingham; 879-3954 (h), 934-5457 (o); Developmental Disabilities, Section IX; Ph.D., University of Alabama/Tuscaloosa; Research related to individuals who have severe/profound developmental disabilities; Provide consultation/training related to service delivery for persons who have developmental disabilities; 1, 2, 3, 4-10-A-B, 5, 6, 7, 8, 9.

BOOTS, LARRY, Professor and Director, OB/GYN Research and Diagnostic Laboratory, University of Alabama/Birmingham; 988-0745 (h), 934-4824 (o); Reproduction, Section IX; Ph.D., Ohio State University; Relationships between coenzymes, estradiol, progesterone, and the endometrium; Provide improved care in infertility and pregnancy through research and quality clinical laboratory reference testing of reproductive hormones and pre-natal screening programs; 1, 4-5-A-B, 5, 7, 8.

## Directory of the Alabama Academy of Science

**BROWN, JERRY WILLIAM**, Professor, Cell Biology and Anatomy, University of Alabama/Birmingham; 871-5433 (h), 934-4495 (o); Developmental Neuroanatomy of the Human Nervous System Section IX; Ph.D., University of Kansas; "Development of Human Trigeminal Nerve Nuclei" and "Development of Nervus Terminalis;" Teaching of medical students and contributing to knowledge of the development of the nervous system.

**BURIEN, JAMES K.**, Research Instructor, Physiology and Biophysics, University of Alabama/Birmingham; 987-7120 (h), 934-7210 (o); Cellular Electrophysiology, Section IX; Ph.D., University of Rhode Island; "Potassium Channels in Human B Lymphocyte Activation" and " $\text{Ca}^{++}$  Inhibits Outward Current Through Single  $\text{K}^+$  Channels In Canine Atrial Myocyte Sarcolemma;" Provide expertise on biomedical research; 1, 2, 3, 4-3-B, 9.

**HUCKNER, ELLEN B.**, Associate Professor of Nursing, University of Alabama/Birmingham; 823-4201 (h), 934-6798 (o); Maternal Child Health Nursing, Section IX; D.S.N., University of Alabama/Birmingham; 1, 8.

**BYNUM, STEVE**, Graduate Student, University of Alabama/Birmingham; 322-1270 (h), 934-8315 (o); Developmental Biology, Section IX; B.S., Auburn University/Auburn; Cell death and digital malformations in retinoic acid-treated embryos; Provide basic research on toxicity and risk assessment of congenital defects; 1, 7.

**CLELLAND, JO**, Associate Professor and Associate Director, Physical Therapy, University of Alabama/Birmingham; 823-4997 (h), 934-3566 (o); Pain Management, Section IX; M.S., Case Western Reserve University; "The Role of the Physical Therapist in Chronic Pain Management" and "Effects of Auricular TENS on Experimental Pain Thresholds;" Provide physical therapy consultation in pain management; 8.

**CORNWELL, PHILLIP E.**, Associate Professor, University of Alabama/Birmingham; 934-4098 (o); Medical Sciences, Section IX; Ph.D., Ohio State University; Vitamin metabolism analysis; 1, 4-5-A-B, 5, 9.

**COSPER, PAULA**, Director, Prenatal Genetics and Associate Professor OB/GYN, University of Alabama/Birmingham; 967-5538 (h), 934-1154 (o); Genetics, Section IX; Ph.D., University of Alabama/Birmingham.

**DAVIS, RICHARD O.**, Professor, OB/GYN, University of Alabama/Birmingham; 991-8057 (h), 934-4226 (o); Medicine, Intrauterine Growth Retardation, Prenatal Diagnosis, Section IX; M.D., Medical College of Georgia; Provide information concerning pregnancy complications; 1, 2, 9.

**DECHESNAY, MARY**, Professor of Nursing, University of Alabama/Birmingham; 934-6116 (o); Nursing, Section IX; D.Sc., University of Alabama/Birmingham; Papers and publications related to research and clinical work with incest families and violence; 1, 2, 9.

## Directory of the Alabama Academy of Science

EMERSON, GERALDINE M., Professor, School of Medicine (retired), Associate Professor, Biochemistry and Scholar, Center for Aging (retired); Medical Science, Section IX; Ph.D., University of Alabama/Tuscaloosa; Aging (Gerontology, Endocrinology, and Neurophysiology).

FINLEY, WAYNE H., Director, Laboratory of Medical Genetics, University of Alabama/Birmingham; 969-1942 (h), 934-4973 (o); Medical Sciences, Section IX; Ph.D., M.D., University of Alabama/Tuscaloosa; Numerous articles on Medical genetics; 1, 2, 3, 4-2-B, 5, 8, 9.

FRANCIS, KENNON T., Professor of Physiology, University of Alabama/Birmingham; 934-3566 (o); Physiology, Section IX; Ph.D., Auburn University; Physiological aspects of exercise and health promotion; Provide resources for development of programs for health promotion; 2, 4-5-B, 7, 9.

GAUBATZ, JAMES W., Associate Professor, Biochemistry, University of South Alabama; 666-0754 (h), 460-6402 (o); Molecular Biology, Section IX; Ph.D., University of Texas/Dallas; DNA damage and repair during development and aging; Education of medical and graduate students in molecular genetics; 1, 2, 8, 9.

GILBERT, FRED, Newnan, Georgia, P. O. Box 1301; Pathology, Section IX; Cytology and Clinical Chemistry.

GOSSMAN, MARILYN R., Professor and Director, Physical Therapy, University of Alabama/Birmingham; 987-0954 (h), 934-3566 (o); Physical Therapy, Section IX; Ph.D., Union Graduate School, Ohio; "Review of Length-Associated Changes in Muscle: Experimental Evidence and Clinical Implications" and "Selected Primitive Reflexes in Children with Cerebral Palsy: Consistency of Response;" Develop Physical Therapists who contribute to the art and science of physical therapy; 1, 2, 3, 4-A-B, 7, 8, 9.

HERBERT, DONALD, Professor of Radiology, University of South Alabama; 460-7064 (o); Applied Health Science, Section IX; Ph.D., University of London; "Multiple Regression Analysis: Applications in the Health Sciences" (with R. Myers) and "Optimization In Radiation Oncology" (with B. Paliwal and C. Orton); Provide statistical models of radiation dose-response; 2, 4-5-A-B, 5, 7, 9.

HOPKINS, JOHN B., Associate Professor of Family Medicine and Director of Behavioral Medicine for Family Programs, University of Alabama/Huntsville; 883-1593 (h), 536-5511 (o); Clinical-Developmental Psychology, Section IX; Ph.D., Peabody College, Vanderbilt University; Provide expertise, advice, and counsel regarding psychology and mental health issues; 1, 2, 3, 4-flexible-A-B, 5, 7, 9.

HUGHES, EDWIN R., Director of Graduate Studies, Basic Medical Sciences, University of South Alabama; 344-3855 (h), 460-6153 (o); Endocrinology, Biology, and Medicine, Section IX; M.D., University of Utah; Numerous publications in mechanisms of steroid hormone area; 1, 2, 3, 4-5-A-B, 5, 9.

## Directory of the Alabama Academy of Science

HUGHES, GLENN H., Co-Director, Center For Aging University of Alabama/Birmingham; 979-2592 (h), 934-5619 (o); Gerontology/Psychology, Section IX; Ph.D., Tulane University; Cardiovascular disease epidemiology-geriatrics, gerontology; 1, 2, 3, 4-B, 7.

HUNTER, GARY R., Associate Professor, University of Alabama/Birmingham; 822-2158 (h), 934-2446 (o); Exercise Physiology, Section IX; Ph.D., Michigan State University; Research on metabolism and body composition during and as a consequence of high intensity exercise; Provide guidance in setting guidelines for wellness/fitness programs and conduct research in exercise physiology; 1, 2, 3, 5, 7.

KATZ, JUDD A., Associate Professor of Psychology, Auburn University at Montgomery; 271-9309 (o); Rehabilitation Psychology, Sections VIII & IX; Ed.D., University of Georgia; "Tactile Stimulus Preceptor for a Hand Prosthesis" and "Using a Natural Operant as a Screening Device to determine the Existence of Heating;" Provide information on the development of patient rehabilitation plans and prothesis design; 1, 7, 8, 9.

KEITH, ROBERT E., Associate Professor, Nutrition and Foods, Auburn University/Auburn; 821-1188 (h), 826-4261 (o); Nutrition and Foods, Section IX; Ph.D., Virginia Tech; Research & publications in the areas of sports nutrition and vitamin status; "Ascorbic Acid Status of Smoking and Non-smoking Adolescent Females;" 2, 3, 9.

KELLEY, JEAN A., Assistant Dean, Graduate Programs in Nursing, University of Alabama/Birmingham; 595-7161 (h), 934-3485 (o); Health Sciences, Section IX; Ed.D., University of Alabama/Tuscaloosa; "A Systems Approach to the role of the Nurse Administrator in Education and Practice" and "Nursing Education - Nursing Administration Collaboration in Research;" Provide leadership in graduate nursing education; 2, 9.

KITTRELL, ELIZABETH JONES, 344-0297 (h), 434-3614 (o); Nursing, Section IX; M.S.N., University of Alabama/Birmingham; "Stress Perceptions of Neonatal Intensive Care Unit Nurses In Their Work Environment;" Provide expertise in womens' health issues; 2, 3, 6, 7, 9.

KLEINSTEIN, ROBERT N., Professor and Chairman, Department of Optometry, University of Alabama/Birmingham; 934-3036 (o); Optometry and Public Health, Section IX; O.D. & Ph.D., University of California/Berkeley; Promotion of eye/vision care and improvement of visual efficiency/eye safety in the work place; 1, 2, 3, 7, 9.

KNOPKE, HARRY J., Executive Assistant, Associate Professor of Behavioral and Community Medicine, University of Alabama/Tuscaloosa; 348-5104 (o); Medical Education, Section IX; Ph.D., University of Wisconsin/Madison; "BioPrep: A Premedical Program for Rural High School Students;" Continue education and community development efforts at the state and county levels; 2, 4-A-B, 5, 7, 8, 9.



## Directory of the Alabama Academy of Science

**LAMON, EDDIE W.**, Professor of Surgery, Microbiology, and Comparative Medicine, University of Alabama/Birmingham; 967-3759 (h), 934-3072 (o); Tumor Immunology, Biological/Medical Sciences, Section IX; M.D., Medical College of Alabama, D.Sc., Karolinska Institute, Sweden; Numerous studies and articles on immunity to virus-induced tumors; Provide fundamental concepts of cancer immunity with potential for vaccine development; 1, 2, 3, 7, 8, 9.

**LEEPER, JAMES D.**, Chair, Department of Behavioral and Community Medicine, University of Alabama/Tuscaloosa; 553-1899 (h), 348-1355 (o); Biometry, Epidemiology, Health Services Research, Section IX; Ph.D., University of Iowa; Incomplete longitudinal data analysis, maternal and child health, and mental health; Assess health problems of communities and evaluate interventions; 1, 2, 3, 7.

**LONGENECKER, GESINA L.**, Professor of Biomedical Sciences and Associate Professor of Pharmacology, University of South Alabama; 342-4674 (h), 460-7056 (o); Pharmacology, Section IX; Ph.D., Cornell University Graduate School of Medical Sciences; Influence of components of tobacco on biochemistry of blood/blood platelet function/sickle cell disease; Have extensive experience in research, teaching, and grant preparation; 2, 4-2 or 3-A-B, 7, 8, 9.

**MCCALLUM, CHARLES A.**, President, University of Alabama/Birmingham; 934-0771 (h), 934-4636 (o); Dentistry and Medicine, Section IX; D.M.D., Tufts University, and M.D., University of Alabama School of Medicine; Facial skeletal development; Provide information relative to the delivery of health care and the education of health professionals; 1, 2, 3.

**MEEZAN, ELIAS**, Professor and Chairman, Department of Pharmacology, University of Alabama/Birmingham; Pharmacology, Section IX; 1, 2, 3.

**MYERS, LAWRENCE J.**, Assistant Professor, Auburn University/Auburn; 887-6880 (h), 826-4425 (o); Sensory Neurophysiology, Section IX; Ph.D., Oklahoma State University; "Use of Animals for Detection of Land Mines and Other Explosives" and "Threshold of the dog for Detection of Inhaled Eugenol and Benzaldehyde;" Provide expertise in biosensor technology for government and industry for security and/or enforcement; 1, 2, 3, 4-10-A-B, 6, 7, 9.

**NANDA, NAVIN C.**, Professor of Medicine and Director, Heart Station and Echocardiography - Graphics Laboratories, University of Alabama/Birmingham; 871-5306 (h), 934-8256 (o); Cardiology, Section IX; M.D., Bombay University/India; Echocardiography; 1.

**NAVIA, JUAN M.**, Ph.D., Professor and Chairman, Department of Public Health Sciences, University of Alabama/Birmingham; 822-4901 (h); 934-2288 (o); Nutrition, Biology, Section IX; Ph.D., Massachusetts Institute of Technology; Research mostly in nutrition and diet (foods) and their effects on the development of oral tissues and their susceptibility to disease; Assist as a resource in the area of nutrition and public health issues in international settings.

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OWINGS, WILLIAM O., Professor, Department of Family Medicine, University of Alabama/Tuscaloosa; 926-7758 (h), 926-4646 (o); Medicine, Section IX; M.D., Tulane University; 1, 2, 3, 7, 8, 9.

PETERS, HENRY B., Executive Director, UAB Research Foundation, Professor Emeritus, School of Optometry, University of Alabama/Birmingham; 823-2434 (h), 934-9911 (o); Optometry, Section IX; O.D.M.A.; Technology transfer from UAB research to new high tech enterprise in Alabama; 1, 2, 3, 4-ad hoc, 5, 9.

PHILLIPS, JOSEPH B., Associate Professor of Pediatrics, University of Alabama/Birmingham; 678-8149 (h), 934-9193 (o); Perinatal Medicine, Fetal/Neonatal Physiology, Section IX; M.D., University of North Carolina; Provide information on the importance of neonatal care in reducing neonatal mortality rates and improving outcome; 2, 3, 7, 8, 9.

PIERCE, JOHN THOMAS, Associate Professor, Industrial Hygiene, University of North Alabama; Health sciences, Section IX; Ph.D., University of Oklahoma Health Science Center; Dermal absorption, risk assessment (UV light); Provide careful consideration of occupational and environmental impacts of economic growth; 1, 2, 3, 4-1-A-B, 5, 6, 7, 8, 9.

PIERONI, ROBERT E., Professor of Internal Medicine and Family Medicine, College of Community Health Sciences, University of Alabama/Tuscaloosa; 345-0606 (h), 348-1330 (o); Medicine, Section IX; M.D., Pennsylvania State University; over 200 publications (including textbooks); 1, 2, 3, 4-5-A-B, 5, 7, 8, 9.

PILLION, DENNIS J., Associate Professor of Pharmacology, University of Alabama/Birmingham; 979-5095 (h), 934-4570 (o); Endocrinology, Medical Sciences, Section IX; Ph.D., Medical College of Ga.; Insulin receptors, chloride and sulfate measurements and pancreatic B-cell transplants; Provide consultation to emerging industries dealing with molecular biology, drug development, diabetes mellitus, transplantation, etc.; 1, 2, 4-5, 5, 7, 8.

PITTMAN, JAMES A., JR., Dean, University of Alabama School of Medicine; 934-1111 (o); Internal Medicine, Endocrinology, and Nuclear Medicine, Section IX; M.D., Harvard Medical School; 177 publications, chiefly on thyroid physiology and diseases; Help provide topnotch medical school at UAB; 9.

ROOZEN, KENNETH J., Dean of the Graduate School, University of Alabama/Birmingham; 979-2140 (h), 934-0622 (o); Microbiology, Section IX; Ph.D., University of Tennessee; "The Effect of B-Cell Stimulation on Hybridoma Formation" in Monoclonal Antibodies and T Cell Hybridomas Provide research and graduate education program development. Also, encourage coordinated university industry cooperation; 1, 2, 3, 4-20-B, 5, 9.

## Directory of the Alabama Academy of Science

SCHNAPER, HAROLD W., Director, Center For Aging, University of Alabama/Birmingham; 871-6069 (h), 934-4399 (o); Medicine, Section IX; M.D.; Numerous scientific publications on cardiovascular physiology, hypertension, and clinical trials of treatment and prevention; Provide teaching, health care, research in health areas as an aid to bettering health of the Alabama aging; 2, 3, 7.

SHEPARD, RICHARD B., Associate Professor, Division of CV Surgery, University of Alabama/Birmingham; 967-3442 (h), 934-4672 (o); Section IX; M.D., University of Pennsylvania; Cardiovascular physiology, applied bioengineering and CV surgery; Accomplish research in UAB School of Medicine; 1 (CV only), 2, 7.

SHOEMAKER, RICHARD L., Professor of Physiology and Biophysics, University of Alabama/Birmingham; 979-9712 (h), 934-2622 (o); Electrophysiology of Cell Membrane Transport, Section IX; Ph.D., University of Alabama/Tuscaloosa; "Altered Regulation of Airway Epithelial Cell Chloride Channels in Cystic Fibrosis" and "Characteristics of Ionic Channels in Vascular Smooth Muscle;" Provide consultation with academic and commercial groups; 2, 3, 7.

SKALKA, HAROLD W., Professor & Chairman, Department of Ophthalmology, University of Alabama/Birmingham; 672-7686 (h), 425-8507 (o); Ophthalmology, Section IX; M.D., New York Medical School; 50 publications related to ophthalmology; 1, 2.

WELLS, DAVID J., Assistant Professor of Pathology, University of South Alabama Medical Center; 666-6910 (h); 471-7799 (o); Biochemistry, Section IX; Ph.D., Vanderbilt University; Role of growth factors in normal and abnormal organ development; Provide evaluation of basic and applied medical research and new product usefulness; 1, 2, 3, 4-3-A-B, 5, 7, 8, 9.

WESTERFIELD, R. CARL, Professor of Health, University of Alabama/Tuscaloosa; 556-3399 (h), 348-8362 (o); Health Education, Section IX; Ph.D., University of Toledo; Factors related to atherosclerosis and health behavior; Provide health education and health promotion in schools, community, and worksites; 1, 2, 3, 4-A-B, 5, 7, 8, 9.

WINTERS, ALVIN L., Associate Professor of Microbiology and Biochemistry, University of Alabama/Tuscaloosa; 752-5392 (h), 348-1019 (o); Virology, Section IX; Ph.D., Kansas State University; Animal model of adenoviral infection and antiviral immunomodulation; Provide research involving compounds with antiviral activity; 2, 4-5-B, 5, 7.

WRIGHT-EICHELBERGER, LISA, Assistant Dean, School of Nursing, Auburn University/Auburn; 297-7322 (h), 826-5666 (o); Health Science, Section IX; D.S.N., University of Alabama/Birmingham; "Meeting Needs: The Reciprocal Process of Breast Feeding Older Children;" 1, 2, 3, 9.

## Directory of the Alabama Academy of Science

ZORN, GEORGE L., Associate Professor of Surgery, University of Alabama School of Medicine; 579-5213 (h), 934-2536 (o); Medicine, Section IX; M.D., Emory University; Clinical cardiac and pulmonary transplantation; Provide clinical development of pulmonary transplantation; 1, 2, 3, 9.

### ENGINEERING AND COMPUTER SCIENCE

ALRIGHT, C. WESLEY, Research and Development Engineer, Ford Aerospace and Communications, Huntsville, Alabama; 880-4017 (o); Biology and Psychology, Section X; M.S., University of Alabama/Huntsville; "Studies on the Nuclear Translocation of the Estrogen-Receptor Complex;" Currently working on the computer processing of exoatmospheric radar data; 1.

BECK, O. OSCAR, Professor, Mathematics and Computer Science, University of North Alabama; 767-2850 (h), 760-4620 (o); Mathematics, Engineering, and Computer Science, Section X; Ph.D., Auburn University/Auburn; 1, 2, 5, 6.

CHOWDHURY, RISHI R., Technical Advisor, Federal Express Corporation; (901) 794-3012 (h), (901) 369-3323 (o); Computer Science, Section X; M.S., UAB and MEA, Memphis State University; Genetic simulation, structural analysis and design, and simulation; 1, 4-10-A-B, 7, 8, 9.

GLOVER, TERRY C., Assistant Professor, Civil Engineering, University of South Alabama; 928-0825 (h), 460-6174 (o); Civil Engineering, Section X; Ph.D., University of Alabama/Tuscaloosa; Provide computer knowledge to youth of Alabama; 2, 3, 4-(5-10)-B, 5, 6, 7, 8, 9.

HARRISON, B. KEITH, Assistant Professor, University of South Alabama; 666-7801 (h), 460-6160 (o); Chemical Engineering, Section X; Ph.D., University of Missouri/Rolla; "An Equation of State Description of Weak Electrolyte VLE Behavior;" Serve as a resource in chemical process simulation and physical property or phase equilibria predictions; 1, 2, 3, 5, 6, 7.

HIRTH, LEO J., Basore Professor of Chemical Engineering, Auburn University/Auburn; 887-9550 (h), 826-4827 (o); Chemical Engineering, Section X; Ph.D., University of Texas/Austin; Direct reduction of Alabama brown ore; Provide process and plant design; 2, 3, 4-5-B, 5.

HOLLAND, J. READ, Director, School of Mines and Energy Development, University of Alabama/Tuscaloosa; 345-1747 (h), 348-4763 (o); Physical metallurgy and Metallurgical Engineering, Section X; D. Engrg., University of Kentucky; Physical Metallurgy, materials science and energy, and mineral resource development; Provide knowledge of the development potential of energy and mineral resources. Also, have familiarity with their industrial applications and role in economic development; 1, 2, 3, 4-A-B, 5, 7.

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HOLLIS, DANIEL L., JR., Professor, University of Alabama/Tuscaloosa; 553-4241 (h), 348-6351 (o); Nuclear Engineering, Section X; Ph.D., Texas A&M University; Metallurgical plasma, bremsstrahlung shielding in space, fission product utilization, and neutron activation analysis; Provide nuclear energy utilization; 1, 2, 3, 4-10-A-B, 5, 6, 7, 9.

HOOL, J. N., Professor, Industrial Engineering, Auburn University/Auburn; 821-4125 (h), 826-4340 (o); Industrial Engineering, Section X; Ph.D., Purdue University; Provide process control and product, process design, and improvement methods; 2, 3, 4-4-A, 5, 9.

KADER, JAC B., President and Principal Engineer, Kader Robotics Corporation; 854-6820 (o); Automation and Robotics, Section X; B.S.I.E., University of Southern California; Enhance Alabama's role as a space engineering and development center; 1, 2, 3, 4-5-B, 7, 9.

LANE, JAMES H., Associate Professor of Civil Engineering, University of South Alabama; 460-6174 (o); Structural Analysis and Design, Section X; 2, 3, 4-4-A-B, 5, 6, 7, 8, 9.

MURKHERJEE, N.L., Associate Professor, Tuskegee University; 887-3300 (h), 727-8050 (o); Chemical Engineering, Section X; D. Engr., Germany; Coal gasification/combustion and shale oil hydroprocessing; 1, 2, 3, 6, 7, 9.

RODGERS, MARSHALL R., Consultant (General Manager, SCB, retired); 823-1411 (h), 825-7609 (o); Science, Engineering, Administration, and Costs, Section X; B.S.E.E., Auburn University/Auburn; 1, 2, 3, 4-10-B, 5.

RODRIGUEZ, HAROLD V., Dean of Engineering, University of South Alabama; 666-2636 (h), 460-6140 (o); Chemical Engineering, Section X; Ph.D., Louisiana State University; Oil production research.

### ANTHROPOLOGY

GILLILAND, M. JANICE, Assistant Director, BioPrep, University of Alabama/Tuscaloosa; 333-1064 (h), 348-7947 (o); Anthropology, Section XI; M.A., University of Alabama/Tuscaloosa; Adolescent growth, and nutritional anthropology and epidemiology; 1, 2, 7, 8.

HILL, MARY CASSANDRA, Graduate Intern, Office of the Dean, College of Arts and Science, University of Massachusetts/Amherst; (413) 548-9489 (h), (413) 545-2627 (o); Anthropology, Section XI; M.A., University of Tennessee, Knoxville; "Microbacterial Disease In Early Human Populations" (current Anthropology) and "Porotic Hyperostosis: Iron Deficiency as Evidenced in Skeletal Tissues;" 1, 2, 3, 4-30-B, 5, 7, 8, 9.

HOLLINGSWORTH, CARYN Y., Graduate Student, University of Alabama; 879-8007 (h), 934-3508 (o), Archaeology, Section XI; B.A., University of Alabama/Birmingham; Provide laboratory and theoretical analysis of Alabama archaeology and its place in Southeast pre-history; 4-10-B, 5, 8.

Directory of the Alabama Academy of Science

ROWE, BOBBY, Instructor, Enterprise State Junior College; History and Anthropology, Section XI; Ph.D., Walden University; **Dehumanizing factors in long term care institutions**; 3, 4-(5-10)-B, 5, 6.

SEWASTYNOWICZ, JAMES, Associate Professor, Jacksonville State University; 435-8730 (h), 231-5781 (o); Cultural Anthropology, Applied Cultural Change, and Latin America, Section XI; Ph.D., Ohio State University; "Community Power Brokers and National Political Parties in Rural Costa Rica" and "'Two Step' Migration and Upward Mobility on the Frontier: The Safety Valve Effect in Pejibaye, Costa Rica;" **Provide analysis of cultural impact on local population of proposed development projects**; 1, 4-10-A-B, 5, 6, 7, 8, 9.

CONSTITUTION AND BY-LAWS OF THE  
ALABAMA ACADEMY OF SCIENCE  
(as amended through March 1988<sup>1</sup>)

ARTICLE I--NAME

The name of this corporation shall be the Alabama Academy of Science.

ARTICLE II--OBJECTS

The objects for which the corporation is formed are:

1. To promote the development of interest in scientific matters in the State of Alabama;
2. To provide means for publication of scientific papers and abstracts;
3. To provide opportunity for increased cooperation and fellowship among its members;
4. To cooperate with other organizations having similar aims;
5. To render public service in scientific matters;
6. To promote the interest in and study of science by the youths of Alabama;
7. To provide for and award scholarships to deserving youths in Alabama;
8. The Alabama Academy of Science shall not have any capital stock, shall not pursue any of its objects or purposes for pecuniary profit to any of its members, and no part of its net receipts shall inure to the benefit of any private shareholder or individual.

ARTICLE III--LOCATION

The office of the Academy shall be in Birmingham, Jefferson County, Alabama.

ARTICLE IV--POWERS

In furtherance, but not in limitation, of the powers conferred by statute, the Academy shall have power:

1. To charge an initiation fee and membership dues to provide income sufficient to meet the needs of its activities;
2. To acquire and hold real property and personal property, stocks in business corporations, bonds and other evidences of indebtedness, to receive property by gift, will, or device, and to hold the same in conformity with all lawful conditions imposed by the donor; to sell, lease, or otherwise alienate its property and to exercise such other powers as are incident to private corporations, but not for the pecuniary gain of any member.

## Constitution and By-Laws

3. To borrow money and to secure the payment thereof by mortgage or deed of trust on all or any part of its property, real or personal or both;
4. To apply for, obtain, register, purchase, lease or otherwise to acquire, and to hold, use, own, operate and introduce, and sell, assign, or otherwise to dispose of, any trademarks, trade names, patents, inventions, improvements and processes used in connection with or secured under letters patent of the United States, or elsewhere; and to use, exercise, develop, grant licenses in respect of or otherwise turn to account any such trademarks, patents, licenses, processes and the like, or any property or rights.

### ARTICLE V--TRUSTEES

The names, post office addresses, and terms of office of the incorporating Trustees<sup>2</sup> are as follows:

<u>Name</u>	<u>Address</u>	<u>Term</u>
Henry L. Jennings	Title Guarantee Building, Birmingham	3 yrs.
Arthur T. McWane	McWane Cast Iron Pipe Company, Birmingham	3 yrs.
Carl B. Fritsche	Reichold Chemical Company, Tuscaloosa	2 yrs.
George R. Stuart	Birmingham-Southern College, Birmingham	2 yrs.
Harwell G. Davis	Howard College, Birmingham	1 yr.
James L. Kassner	University, Alabama	1 yr.

### ARTICLE VI--MEMBERS

1. All members of the Alabama Academy of Science in good standing shall become members of the Corporation, and different classes of membership together with the rights and privileges of each class shall be determined by the By-Laws of the Corporation.
2. There shall be no personal, individual or other liability whatsoever on the part of any member of the Academy, either for the debts of the Academy or for any act or omission of the Academy or of any officer, agent or employee thereof.

### ARTICLE VII--MEETING OF THE MEMBERSHIP

1. There shall be an annual meeting of the members of the Academy, the time and place to be determined by the Executive Committee at least twenty days in advance;
2. Special meetings of the membership may be called by the President and he shall call such meetings on the written request of ten (10) active members;
3. Notice of all meetings of the members shall be in writing mailed to the last known address at least ten (10) days in advance of such meeting. The members present at any such meeting shall constitute a quorum for the transaction of business;



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4. The rights of members to vote at meetings of the membership shall be determined by the By-Laws.

### ARTICLE VIII--OFFICERS

1. The officers of the Academy shall be elected by the membership and shall be twelve Trustees, a President, a First Vice-President (President-elect), a Second Vice-President, chairmen for the various sections, vice-chairmen for the various sections, a Secretary, a Treasurer, a Councilor of the American Association for the Advancement of Science, an Editor of the Journal, three Counselors of the Junior Academy, and a Coordinator of Regional Science Fairs.
2. At the close of each annual meeting, the First Vice-President (President-elect) shall become President of the Academy. A new First Vice-President (President-elect), a Second Vice-President, and other officers to fill all other offices becoming vacant following the current annual meeting shall be elected by a plurality of the votes of the members present at said meeting and their terms of office shall begin at the close of the meeting.
3. The tenure of office shall be one year or until successors shall be elected, except that the section chairmen and vice-chairmen shall serve two years and the Trustees, the Secretary, the Treasurer, the Councilor of the American Association for the Advancement of Science, the Editor of the Journal, the Coordinator of Regional Science Fairs, and the three Counselors of the Junior Academy, one of whom shall be elected each year to replace one whose term is expiring, shall serve three years and shall be elected triennially.
4. The affairs of the Academy shall be managed by an Executive Committee which shall be composed of the elected officers together with all active past Presidents and the chairmen of standing committees authorized by the By-Laws.
5. The Executive Committee shall have the power to make and alter the By-Laws of the Academy; to hold meetings at such places and at such time as shall from time to time be designated by the By-Laws or by resolution of the committee; to fix the amount of fees and dues to be collected from members and shall have such other powers, not inconsistent herewith as may be necessary to carry out the purposes of the Academy. The By-laws may prescribe the number of members of the committee necessary to constitute a quorum which number may be less than a majority of the whole number of the members.
6. Vacancies on the Executive Committee that occur between annual meetings shall be filled in the following manner: If the office of President shall become vacant, the First Vice-President (President-elect) shall become President. If the office of First Vice-President (President-elect) shall become vacant, the office shall be filled by the Second Vice-President. Vacancies in any other offices of the Academy shall be filled by the

## Constitution and By-Laws

Executive Committee convened on call of the President or, if necessary, by the Secretary.

7. At his earliest convenience, the President shall make the necessary appointments to the Nominating Committee. This committee shall consist of six (6) members appointed for two (2) year terms, with three members going on and three going off each year. The President shall also appoint a chairman for the ensuing year. This committee shall be responsible for determining which elective offices are to be vacated and carrying on appropriate consultation regarding qualified nominees. The nominees shall be presented to the Academy meeting as a whole.
8. The Trustees shall be ex-officio members of the committee on finance for the Academy and shall take and hold title to all real property of the Corporation and shall act as custodians of all money and personal property of whatsoever kind except membership fees and dues, acquired by the Academy for purposes other than the general operating expenses thereof, in trust for the Academy, and shall disburse such money, dispose of such property, borrow money for such purposes other than the operating expenses of the Academy and make any issue notes, bills, bonds, and other evidences of indebtedness and convey by mortgage or deed of trust all or any part of the property owned, real or personal or both, by the Corporation, to secure the payment of any debts contracted by the authority of the Executive Committee; but before such mortgage or deed of trust can be executed, the majority of the Executive Committee shall have first authorized the incurring of the debt and the execution of such mortgage or deed of trust on all or part of the real or personal property, or both of the Corporation, which authorization must be made at a regular meeting or at a special meeting of the Executive Committee specifically called for the purpose. And the Executive Committee at any regular meeting, or at any special meeting called for that purpose, may grant authority to the Board of Trustees to convey by mortgage or deed of trust any or all of its property, real or personal, it may then own or thereafter acquire, for the purpose of securing any debts contracted by the Trustees for the Corporation.
9. The Trustees shall be elected to serve staggered terms of three (3) years unless specifically elected to serve a lesser term. They are eligible for reelection. The Board of Trustees shall meet immediately after the Annual Business Meeting to transact necessary business and to elect one of its members to serve as Chairman of the Board, either for the ensuing year or for the duration of his/her term as Trustee.
10. In case of any increases in the number of Trustees, the additional Trustees shall be elected as may be provided in the By-Laws and one-third of their number shall be elected to serve for one year, one-third for two years, and one-third for three years.
11. In case of any vacancy in the class of Trustee through death, resignation, disqualification or other cause, the Executive

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Committee, at any regular meeting, or any special meeting called for that purpose, by affirmative vote of the majority of the committee present, may elect a successor to hold office for the unexpired term.

### ARTICLE IX--DURATION

The duration of the Corporation shall be perpetual.

### ARTICLE X--AMENDMENTS

This certificate may be amended at any annual meeting by a three-fourths vote of the attending members.

## BY-LAWS OF THE ALABAMA ACADEMY OF SCIENCE

### ARTICLE I. MEMBERSHIP CLASSIFICATION

Sec. 1. The membership of the Academy shall consist of the following classes:

a) *Member*: Membership shall be open to any person who desires to support the objectives of the Academy as defined in the Constitution.<sup>3</sup>

b) *Collegiate Member*: Any person interested in the promotion of science in Alabama who is registered as a student in a college or university may qualify as a collegiate member for a maximum of five years.

c) *Emeritus Member*: Full members upon formal retirement and after at least twenty (20) years of active membership in the Alabama Academy or other state academy, may upon application to the secretary, have their status changed to Emeritus member with full voting and office holding privileges.

d) *Honorary Member*: Members of the Academy who have received outstanding recognition beyond the State of Alabama shall be eligible for honorary membership. Not more than two honorary members shall be elected in any one year.

e) *Life Member*: Any member of the Academy may become a life member by paying into the treasury at one time the amount established in Article II. (e).

f) *Fellow*: Members of the Academy who are Fellows of the American Association for the Advancement of Science shall be classed as Fellows of the Academy.

g) *Complimentary Member*: High school science clubs are classed as complimentary members. The Counselor of the Junior Academy shall certify to the Secretary of the Academy by January 1 of each year those clubs entitled to such membership.

h) *Sustaining Member*: Any individual, corporation, or organization may become a sustaining member of the Academy. Each corporate or

## Constitution and By-Laws

organization sustaining member is entitled to designate two individuals from its organization to represent it as active members in the proceedings of the Academy.

Sec. 2. Collegiate members shall not hold office nor vote. Members not residing in Alabama may not hold elective offices, but may serve on committees of the Academy.

Sec. 3. The membership year and the fiscal year shall correspond to the calendar year.

a) New members joining October 1 or thereafter shall be members as of January 1 the following year.

Sec. 4. Payment of the required dues and determination by the Secretary that the application meets the requirements for one of the classes of membership set out in Sec. 1. above shall constitute admission to membership.<sup>3</sup>

### ARTICLE II. DUES

Sec. 1. The dues for the several classes of membership shall be as follows<sup>3</sup>:

a) *Member*: Fifteen Dollars (\$15.00) per annum.

b) *Collegiate Member*: Ten Dollars (\$10.00) per annum.

c) *Emeritus Member*: Five Dollars (\$5.00) per annum.

d) *Honorary Member*: None.

e) *Life Member*: Two Hundred Dollars (\$200.00).

f) *Fellow*: Fifteen Dollars (\$15.00) per annum.

g) *Complimentary Member*: None.

h) *Sustaining Member*: Individual, Twenty-five Dollars (\$25.00) or more, per annum. Corporations and organizations, One Hundred Dollars (\$100.00) or more, per annum.

Sec. 2. No one shall be eligible for office who is in arrears in the payment of dues.

Sec. 3. Members in arrears with their dues as of February 1 shall be dropped from membership.

### ARTICLE III. SECTIONS

Sec. 1. The Academy shall have the following scientific sections:

I. Biological Sciences

II. Chemistry

III. Geology

IV. Forestry, Geography, Conservation, and Planning<sup>4</sup>

V. Physics and Mathematics

VI. Industry and Economics

VII. Science Education

VIII. Social Sciences

IX. Health Sciences

X. Engineering and Computer Science<sup>5</sup>

XI. Anthropology

ARTICLE IV. COMMITTEES

Sec. 1. Standing committees of the Academy shall be set up as indicated below and serve for the terms and purposes stated.

a) *Steering Committee*: The Steering Committee shall consist of the President, immediate Past President, First and Second Vice-Presidents, Secretary, and Treasurer. The Steering Committee is authorized to handle routine jobs of the Academy which shall arise between Executive Committee meetings. It is responsible to the Executive Committee and is not authorized to make decisions for the Academy.

b) *Committee on Membership*: This committee consists of the vice-chairmen of the sections and a chairman appointed by the President-elect. The chairman will serve a one-year term but may be reappointed to successive terms until he has served three years. The committee shall also include such other persons as the chairman deems necessary to provide. The committee shall, through its statewide membership, seek to secure new members, solicit contributing memberships, and handle such investigations and projects as may be assigned to it by the officers or committees of the Academy.

c) *Committee on Research*: The President-elect shall appoint one member to this committee of five (5) by the annual meeting and the President shall fill other vacancies as they occur. Terms shall be staggered and for five (5) years. The chairman will serve a one-year term, but may be reappointed to successive terms until he has served three years. He must have served previously on this committee. The committee shall encourage scientific research in Alabama by whomsoever initiated and conducted, investigate possible sources of funds to be awarded by the Academy to research scientists, and make recommendations on the placing of such funds for the greatest benefit to science. The committee shall recommend any awards and the nature of each recognizing scientific accomplishments by high school students, college undergraduates, graduate students, and research scientists. Any funds awarded shall be expended directly for the purposes designated by a member of the Academy at the institution and/or department receiving the grant.

d) *Committee on Long-range Planning*: The Committee shall consist of four past presidents of the Academy, serving staggered terms of four years each, and shall be designated by the President-elect. The committee shall elect its chairman who shall serve a one-year term. The committee shall respond to any and all assignments referred to it by the President or the Executive Committee and shall make recommendations in the best interest of the Academy. The committee may also originate recommendations to the Executive Committee on matters considered of significance to the Academy.

e) *Auditing Committee*: The President-elect shall appoint annually two auditing committees of two members each, one for the Senior Academy and one for the Junior Academy. The committee shall examine and report to the Academy upon the financial records of the Treasurer of the Academy and the Treasurer of the Junior Academy, respectively, at the meeting for which they were appointed.

f) *Editorial Board*: The Editorial Board shall consist of three members serving staggered terms of three years each, and the annual

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vacancy shall be filled by appointment by the President-elect. The Editor of the Journal is an additional ex-officio member of the Board. The Editorial Board shall concern itself with broad editorial policies and with problems of finance and shall act in a general advisory capacity to the Editor of the Journal. The chairman of the Editorial Board, appointed for three years, shall be responsible for all matters pertaining to institutional subscriptions and exchanges for the Journal with the approval of the Executive Committee.

g) *Committee on Junior Academy*: This committee shall consist of the Counselors of the several regions, the state officers of the Junior Academy of Science, the sponsors of the state officers of the Junior Academy, and the three Counselors elected by the Alabama Academy of Science. The duties of this committee shall be to coordinate the activity of the several regions of the Junior Academy in cooperation with the Coordinator of Regional Science Fairs, to promote organization of chapters and by all possible means promote the welfare of the chapters, the regions and the entire Junior Academy.

h) *Committee on Place and Date of Meetings*: The President-elect shall appoint one member to this committee of five (5) prior to taking office and the President shall fill other vacancies as they occur. Terms shall be staggered and for five (5) years. The chairman will serve a one-year term, but may be reappointed to successive terms until he has served three years, and must have served previously on the committee. The committee will make recommendations at the annual business meeting concerning the time and place for holding subsequent annual meetings.

i) *Committee on Local Arrangements*: In consultation with the administration of the host institution, the President shall appoint a Local Arrangements chairman. The Local Arrangements chairman shall appoint subchairmen for the Senior and Junior Academy arrangements and each subchairman shall select the other members of his subcommittee. He is responsible for providing for the physical needs of the Academy at its annual meeting. He shall work closely with the President and the Secretary of the Academy as well as with his subchairmen.

j) *Committee on Newsletter*: The President-elect shall appoint a senior editor at large for the state, and ten (10) associate editors, one from each major institution in the state. The appointees shall constitute the Newsletter Committee and shall serve three (3) year terms. The major institutions shall be determined by inspection of the membership roster by institution. The associate editors shall supply the senior editor with items of interest and concern to the membership. The Newsletter shall also be the medium for conveying items of business from the officers to the membership. The Newsletter shall be published at regular intervals and forwarded to all members in good standing.

k) *Committee on Public Relations*: This committee shall be appointed by the President-elect. The chairman shall serve a one-year term but may be reappointed until he has served three years. This committee shall seek adequate publicity for the meetings and work of the Academy.

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- 1) *Committee on Archives*: The President-elect shall appoint a chairman of the Committee on Archives who shall be the Archivist. The Archivist shall keep in a safe place the Archives of the Academy consisting of back numbers of the Journal, exchange publications, and records of the Academy.
- m) *Committee on Regional Science Fairs*: This committee shall consist of the State Coordinator of Science Fairs and Regional Coordinators of the several regions. The committee shall coordinate the activities of the Regional Science Fairs in cooperation with the Counselors of the Junior Academy of Science.
- n) *Committee on Science and Public Policy*: This committee shall have a two-fold function: (1) To make scientific advice available to personnel at all levels of government in Alabama, and (2) to disseminate scientific information to the people of the State. The chairman shall be appointed by the President-elect for a one-year term, shall be eligible for reappointment, and shall be responsible for seeing that the committee functions.
- o) *Wright A. Gardner Award Committee*: Shall consist of four (4) members appointed by the President for staggered two (2) year terms with a chairman designated for each ensuing year. This award is made by the Alabama Academy of Science to some specific individual for noteworthy achievement in the field of Science during residence in Alabama. AAS members are invited to submit nominations for this award to the chairman of the committee not later than December 1. Members of the committee should encourage AAS members to submit nominations of outstanding persons. Each nomination should consist of a curriculum vitae and a list of publications or other documentation substantiating the person's special contribution to science in Alabama. The nomination material must be summarized in the form of a one-page citation. The committee, upon reaching a decision that an award should or should not be made, must relay this information confidentially to the President of the Senior Academy at least thirty (30) days before the Annual Meeting. In the event of an Award, the President should promptly notify the person selected for the honor. The Gardner Award itself shall be an appropriately executed plaque presented at the annual banquet of the Senior and Junior Academies after the President or the Chairman of the Award Committee has read the citation.<sup>6</sup>
- p) *Emmett B. Carmichael Award Committee*: Shall consist of five (5) members of the Academy representing diverse disciplines, four (4) to be appointed by the President to staggered two-year terms, with the Editor of the *Journal of the Alabama Academy of Science* as the fifth voting member, ex officio. This Award is made by the Academy for the outstanding paper published in the *Journal* during the previous calendar year. The Carmichael Award shall consist of a suitably executed plaque and a \$250 prize, both to be presented at the Annual Joint Banquet. In case there are multiple authors, the Award shall carry all names, and there shall be equitable distribution of the monetary prize. If no paper is considered outstanding for any particular year, the Committee shall make no Carmichael Award for that year.<sup>6</sup>

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### ARTICLE V. DUTIES OF OFFICERS

- Sec. 1. *Trustees*: The duties of the Trustees are as enumerated in the Certificate of Incorporation. They shall have the right to hold meetings, both regular and special, at such time and places as may be convenient; and at such meetings a majority of the Trustees shall constitute a quorum for the transaction of any business which may come before them.
- a) All funds of the Academy which may come into the custody of the Trustees shall be carried in a separate bank account in the name of the Academy. The Trustees may designate one or more of their number to sign checks drawn to such account.
- Sec. 2. *Executive Committee*: The duties of the Executive Committee are set forth in the Constitution.
- a) The Executive Committee shall meet at least twice annually. One meeting shall be called by the President in the Fall. One meeting shall be immediately before the annual meeting of the Academy. The Executive Committee shall consider at these meetings such business as may properly be brought before it and shall make recommendations for action by the business sessions of the entire Academy.
- b) Special meetings of the Executive Committee may be held whenever called by a majority of the members thereof, or by the President. Timely notice of a meeting, stating the time and place thereof and indicating briefly the objective thereof shall be given the members of the committee by mail, by publication, or by other suitable means whereby the notice may be conveyed. At all meetings of the Executive Committee, regular or special, the members present shall constitute a quorum for the transaction of any business which may come before it.
- Sec. 3. *President*: The President shall preside at the sessions of the Academy as a whole, and of the Executive Committee.
- a) The President shall appoint members to fill vacancies on all committees except as otherwise herein provided.
- b) The President shall obtain an appropriate speaker to address the annual banquet. He will share this responsibility with the Counselor of the Junior Academy in alternate years, with the approval of an invitation to the speaker coming from the President of the Academy.
- c) The President and Secretary shall make a site visit to the host institution to evaluate facilities for the annual meeting with the Local Arrangements chairman at least 30 days prior to the Fall meeting of the Executive Committee. A report shall be made at this meeting.
- Sec. 4. *First Vice-President (President-elect)*: During his tenure the First Vice President shall select chairmen and members to all committees provided herein. They shall be appointed and begin their tenure when he becomes President.
- a) He shall become acquainted with the duties and problems of the Secretary through personal visits and other contacts.
- b) He shall work with the Public Relations chairman and the Newsletter chairman in informing the public and the Academy members of the program and activities of the Alabama Academy of Science, its officers, and members.
- c) He shall perform any other duties delegated by the President.
- d) In the absence of the President, he shall chair all meetings.



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- Sec. 5. *Second Vice-President*: During his tenure, he shall review the financial and publication operations of the Academy.
- a) The Second Vice-President shall work with the Committee on Membership and others in building up membership in the sections and the Academy.
  - b) He shall become acquainted with the duties and problems of the Treasurer and the Journal Editor through personal visits and other contacts.
- Sec. 6. *Section Chairmen*: Each chairman in cooperation with the vice-chairman, shall be responsible for presiding over, and planning and arranging the program of his section.
- a) The chairman shall be responsible for transmission of program material to the Secretary by the deadline recommended by the Secretary and approved by the Executive Committee.
  - b) The chairman, in cooperation with the vice-chairman, shall endeavor to build up the membership of the section.
  - c) The section chairman should write to the members of his section, previous to the Secretary's "Call for Titles," encouraging them to participate in the upcoming meeting. In this letter he shall also solicit names of qualified nominees for vice-chairman if that position is about to be vacated.
  - d) At the Friday morning paper session the section members shall vote on which nominee they want for the upcoming two (2) years as vice-chairman. The section's choice should be delivered to the chairman of the Academy Nominating Committee not later than the close of the Friday afternoon session.
  - e) The section chairman shall be alert to the fact that only members in good standing are qualified to be considered for elective positions in the Academy.
- Sec. 7. *Section Vice-Chairmen*: Each vice-chairman shall cooperate with the chairman in the efficient handling of all sessions at the annual meeting.
- a) The vice-chairman shall be secretary of the business meeting of the section and make his report to the Academy Secretary before the annual business meeting.
  - b) In the event that the office of section chairman is vacated, the vice-chairman shall serve as temporary chairman.
  - c) He shall be a member of the Membership Committee of the Academy and shall be responsible for building up the membership in his section with the assistance of the chairman.
- Sec. 8. *Secretary*: The Secretary shall maintain an accurate and up-to-date roster of the Academy membership and their dues record.
- a) The Secretary shall send dues statements to the members for the next calendar year.
  - b) The first dues notice shall be sent October 1, the second notice November 15, and the final notice on January 5. Members in arrears as of February 1, will be dropped from the roll of the Academy and all publications to said member discontinued.
  - c) Upon receipt of dues the Secretary shall check the roll of the members in good standing and forward the funds to the treasurer.
  - d) He shall notify applicants of action on their application of membership.

## Constitution and By-Laws

- e) He shall keep the minutes of the Executive Committee and of the Academy as a whole.
- f) The Secretary in concert with the chairman of Local Arrangements Committee, shall be responsible for the arrangements of the annual meeting, including the drawing up of the general program and the arranging of Sectional, Junior Academy and Gorgas programs sent to him by persons in charge of each area.
- g) He shall be in charge of the preparation, printing and mailing of meeting programs, blanks, notifications, etc.
- h) The Secretary shall provide the incoming President with a revised roll of the Academy membership. He shall also provide each section chairman with an up-to-date list of the members in his or her section.

Sec. 9. *Treasurer:* The Treasurer shall be the recipient of all funds of the Academy derived from dues and fees as collected by the Secretary, but not special funds held by the Board of Trustees as provided by the Constitution.

- a) The Treasurer shall prepare a budget for the next fiscal (calendar) year and present same at the Fall Executive meeting.
- b) The Treasurer shall prepare a financial statement of the Academy for the past calendar year and present same at the Spring Executive Committee meeting.
- c) The Treasurer shall make such disbursement of funds as approved in the budget.
- d) The Treasurer is required to be bonded.

Sec. 10. *Councilor of the AAAS:*

- a) He shall represent the Academy on the Council of the American Association for the Advancement of Science (AAAS) and the Conference.
- b) He shall attend any other meetings of the AAAS conventions which shall be deemed of interest to the Academy.
- c) He shall make a report at the Spring Executive Committee meeting.
- d) The President is authorized to appoint a substitute or alternate Councilor of the AAAS.
- e) Other delegates up to five in number may be designated by the President to attend the annual meeting of the AAAS.

Sec. 11. *Editor of the Journal:*

- a) He shall be responsible for publication of the Journal of the Alabama Academy of Science.
- b) He shall be an ex-officio member of the Editorial Board.

Sec. 12. *Counselors of the Junior Academy:*

- a) Of the three Counselors called for in Article VIII of the CONSTITUTION, one shall be designated as Counselor, and two as Associate Counselors, with the usual seniority attached to the first title.
- b) The Counselor and Associate Counselors shall supervise the activities of the Junior Academy for the Senior Academy, as mutually agreed upon.<sup>7</sup>

Sec. 13. *State Coordinator of Regional Science Fairs:*

The State Coordinator of Regional Science Fairs shall supervise the activities of the Regional Science Fairs.

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### ARTICLE VI. PROGRAM RULES

- Sec. 1. Titles of the papers to be presented at the annual meeting of the Academy must be sent to the chairman of the section, in which the paper is to be presented, prior to the date set by the Executive Committee.
- Sec. 2. Abstracts, typed in the prescribed format, shall be transmitted in the following manner. The original abstract shall be sent to the Editor of the Journal prior to the date set by the Executive Committee. The member shall carry a photocopy of the abstract to the meeting and present it to the presiding officer of the section prior to giving the paper.
- Sec. 3. The section chairman shall screen the authors of scientific papers against his section membership roster. One author must be a member in good standing with the Academy.
- Sec. 4. The section chairman shall compile the program for his section in the prescribed format and forward it to the Secretary prior to the date set by the Executive Committee.
- Sec. 5. Failure to follow the above program rules will result in the section program being omitted from the final printed program.
- Sec. 6. A registration badge is necessary for admission to scientific paper sessions, panel discussions, seminars or symposia held under the auspices of the Academy. The only exception to this rule shall be the case of invited guests of the Academy.
- Sec. 7. The program of the annual meeting shall include the following features:
- (a) Meeting of the Executive Committee.
  - (b) Annual Business Meeting of the Academy.
  - (c) Scientific Section Sessions.
  - (d) Annual Banquet.
  - (e) Meeting of the Board of Trustees.
  - (f) Other activities in keeping with the objectives of the Academy.

### ARTICLE VII. JOURNAL

- Sec. 1. The Journal of the Academy shall be published at least once and not more than four times each year at the discretion of the Editorial Board. It shall contain an account of the business transacted at the annual meeting, papers of outstanding merit, abstracts of all other papers, and such other material as the Editor and the Editorial Board may think proper.

### ARTICLE VIII. THE ALABAMA JUNIOR ACADEMY OF SCIENCE

- Sec. 1. The Academy shall sponsor and supervise the Alabama Junior Academy of Science, composed of high school science clubs.
- Sec. 2. Counselors of the Junior Academy are officers of the Academy and are elected as provided in Article VIII of the Constitution.

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### ARTICLE IX. REGIONAL SCIENCE FAIRS

- Sec. 1. The Academy shall sponsor and supervise the Alabama Regional Science Fairs.
- Sec. 2. The State Coordinator of Regional Science Fairs is an officer of the Academy and is elected as provided in the Constitution.

### ARTICLE X. AMENDMENTS

- Sec. 1. The By-Laws may be amended by a plurality vote of the Executive Committee present at any annual meeting or at any special meeting for that purpose.

### REFERENCES

<sup>1</sup>Historical notes: The Alabama Academy of Science was founded in 1924. The first Constitution was published, without by-laws, in the Journal of the Alabama Academy of Science, Vol. 2, page 20, 1930.

The Articles of Incorporation, offered for record in the Office of the Judge of Probate of Jefferson County on 27 May 1947, were published in the Journal (Vol. 19, pages 68-71, December 1947) followed by By-Laws on pages 71-75.

Over the following 34 years, as revisions were adopted in the Articles and By-Laws to meet needs of the expanding Academy, these were consolidated and documentation appeared at intervals in the Journal. In the last two Journal printings (Vol. 48, pages 148- 163, July 1977; and Vol. 52, pages 79-95, April 1981), headings were "Constitution and By-Laws of the Alabama Academy of Science", although this terminology did not appear in the original incorporation. Ambiguously blank listings were given of probate recording and of Trustees' signatures. It has seemed appropriate to simplify the presentation of our operating documents by omitting this non-identifying material and showing the commonly used heading of "Constitution and By-Laws".

References for Amendments adopted prior to April 1981 can be found on page 95 of the 1981 Journal publication above. Other references given here are to Minutes of Academy Executive Committee meetings, unpublished but officially adopted and available in the files of the Secretary.

<sup>2</sup>These were the Trustees as of the incorporation of the Academy on 27 May 1947. The expanded Board of Trustees now has 12 members (Constitution, Art. VIII, 1.), effective March 1988, as follows:

	<u>Term Expires</u>
(1) Samuel B. Barker, Chairman, The University of Alabama at Birmingham,	1990
(2) Charles M. Baugh The University of South Alabama,	1989
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## Notes



## Notes



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ABSTRACTS

Papers presented at the 65th Annual Meeting  
Auburn University  
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March 23-25, 1988

BIOLOGICAL SCIENCES

ANDROGEN METABOLISM IN THE TESTES OF THE SEA STAR ASTERIAS VULGARIS.  
Gene A. Hines and Stephen A. Watts, Dept. of Biology, U.A.B.,  
Birmingham, AL 35294. Charles W. Walker, Dept. of Zoology, Univ. of  
New Hampshire, Durham, NH 03284.

Whole tissue and homogenate preparations of testes were incubated with  $^3\text{H}$ -androstenedione for 24 hours. Steroid products were extracted and separated using TLC with various organic solvent systems. Radioactivity was detected on a Berthold TLC scanner. In crude tissue homogenates  $^3\text{H}$ -androstenedione was converted primarily to testosterone and also to androstenedione and epiandrosterone. These studies indicate high  $17\beta$ -hydroxysteroid dehydrogenase activity relative to  $5\alpha$ -reductase and  $3\beta$ -hydroxysteroid dehydrogenase activities. Aromatization of androgens to estrogens was not detected. Whole tissue incubations produced the same steroid products and at least ten more unidentified compounds which may include other steroids, steroid esters and products of steroid degradation. Preliminary identification suggests the presence of  $5\alpha$ -androstane- $3\beta,17\beta$ -diol, a potent androgen. These data indicate that: (1) maintenance of intact cells/tissues during  $^3\text{H}$ -androstenedione incubations results in an increase in the formation of steroid products, (2) incubations with whole tissues may more accurately reflect steroid metabolism in vivo than incubations with homogenates, and (3) androgen production in the testes of the sea star may be similar to that occurring in the testes of many vertebrates.

FOOD HABITS OF GULF COAST MEDITERRANEAN GECKOS (HEMIDACTYLUS TURCICUS). Steven D. Carey, Div. of Natural Sciences, Mobile College, Ala. 36613. David H. Nelson, Dept. of Biology, Univ. of South Ala., Mobile, Ala. 36688.

The stomachs of 62 Mediterranean geckos, collected from five north central Gulf Coast cities, were examined for food items. Geckos were collected during the month of July 1984, and the months of May, June, August, and October 1985. Arthropods accounted for all food items. Insects represented 90% of the food, followed by arachnids (3.8%), isopods (5.3%) and centipeds (0.9%). Among the insects, dipterans, springtails, and homopterans were most frequently encountered.

DEVELOPMENT OF CARYOSPORA BIGENETICA IN CULTURED MAMMALIAN CELLS. R. E. Tibbs, Jr., C. A. Sundermann, Department of Zoology & Wildlife Science, Auburn University, AL 36849, D. S. Lindsay, USDA, Animal Parasitology Institute, Beltsville MD, 20705.

Sporozoites of rattlesnake-derived oocysts of Caryospora bigenetica were purified and inoculated onto monolayer cultures of human fetal lung cells, primary cotton rat kidney cells, and primary cotton rat testicle cells. Development of C. bigenetica was the same in all cells types, and the following observations were made with light microscopy. One and 2 days post-inoculation (DPI), intracellular sporozoites and immature meronts were present. Motile, extracellular merozoites were observed 3 DPI, and second-generation merozoites were present 5 DPI. These first- and second-generation merozoites were morphologically different. Nine DPI micro- and macrogamonts were observed, and they developed to unsporulated oocysts by 10 DPI. In vitro sporulation occurred and excystation of sporozoites was observed. Sporozoites penetrated cultured cells and spherical caryocysts formed by 16DPI. Infectivity of in vitro-produced stages was demonstrated as follows. Merozoites were removed from cultured cells 5 DPI and inoculated intra-peritoneally into a mouse; infection resulted. Sporulated, thin walled oocysts removed from cultured cells 12 DPI produced facial swelling in an orally inoculated cotton rat. Infection in these animals was confirmed by observation of stages of C. bigenetica in fresh smears of tissues. Supported by the Alabama Agricultural Experiment Station, Project # 13-0061.

BINDING OF A MURINE SPERM SURFACE COMPONENT TO HOMOLOGOUS ZONAE.

Richard Richardson, H. Boettger, D. Free, S. Rushing, G.R. Poirier, Dept. of Biology, Univ. of Ala. at Birmingham, Birmingham, AL 35294.

Previous investigations suggest that a 15,000 molecular weight, heat-labile component, the acceptor, present on the plasma membrane over the acrosome region of murine spermatozoa participates in sperm-zona binding (Poirier et al., 1987). This presentation, using a monoclonal antibody to the acceptor, demonstrates that solubilized acceptor is able to bind to the zonae of ovarian and ovulated oocytes but not to the zonae of two-cell embryos. The acceptor is also able to bind to solubilized zonae, isolated from unfertilized ovulated eggs, attached to nitrocellulose membranes. The data support the suggestion that the acceptor functions in zona binding.

DERMAL COCCIDIOSIS IN DOGS. C. A. Sundermann, Dept. Zoology & Wildlife, B. L. Blagburn & L. J. Swango, Dept. Pathobiology, Auburn University, AL 36849.

Dermal coccidiosis was induced in dogs by inoculation of sporulated oocysts of Caryospora bigenetica. Oocysts were obtained from the feces of a canebrake rattlesnake, sterilized, and ground with a tissue grinder to release some of the sporocysts. Four 9-week-old dogs were inoculated orally with 10 million oocysts/sporocysts. Three of these dogs received intramuscular injections of methylprednisolone (MPN). Two control dogs received placebo and one also MPN. The 3 dogs that received oocysts and MPN displayed clinical signs of dermal coccidiosis 10 days post-inoculation (DPI). These dogs had periorcular swelling, swollen muzzle with lesions, ocular mucous discharge, edematous nostrils, inflammation of ears and abdominal skin, and spongy footpads. The dogs were recumbant; one was sacrificed 10 DPI. Fresh smears of scrotum, footpad, eyelid and muzzle revealed numerous gamonts of C. bigenetica. Both control dogs appeared healthy 10 DPI. Neither had coccidia present in histological sections of dermis nor were stages seen at necropsy 10 and 14 DPI. The 2 remaining experimental dogs somewhat recovered. These dogs were sacrificed 20 and 67 DPI. Numerous caryocysts were present in eyelid, muzzle, footpad, and abdominal skin. The dog that received oocysts but no MPN appeared healthy; no coccidia were seen in histological sections of dermis. Supported by Alabama Agricultural Experiment Station, Project # 13-0061.

VERTEBRATE NATURAL HISTORY SURVEYS IN AN ALABAMA BRACKISH WATER ESTUARY. Ken R. Marion and John J. Dindo, Biology Dept., Univ. of Alabama at Birmingham, Birmingham, AL 35294.

Seasonal natural history surveys of terrestrial and semi-aquatic vertebrates were conducted during 1986 and 1987 in habitats of the Weeks Bay, Alabama, National Estuarine Reserve. This Reserve is part of a series of estuaries in the United States that have been set aside for the study of estuarine processes and productivity. Weeks Bay is a brackish water estuary with surrounding habitats of marsh, tidal creeks, lowland hardwood forests and mixed lowland forests. One hundred-twelve species of birds, thirty-four species of reptiles and amphibians, and fifteen mammal species have been observed in the Reserve. A small population of the Alabama Red-Bellied Turtle (Pseudemys alabamensis), proposed for federal protection, was also found. These studies represent the most thorough seasonal studies of terrestrial and semi-aquatic vertebrates inhabiting an Alabama brackish water estuary.

CHANNEL CATFISH VITELLOGENIN. James T. Bradley, Dept. of Zoology and Wildlife Science, and John M. Grizzle, Dept. of Fisheries and Allied Aquacultures, Auburn University, Auburn, AL 36849.

In oviparous vertebrates estrogen induces the liver to synthesize vitellogenin (VG), a serum protein sequestered in vitellogenic oocytes and from which lipovitellin (LV) and phosvitin (PV) are derived. Our objective was to identify VG in the channel catfish, Ictalurus punctatus. Intraperitoneal injection of estradiol-17 $\beta$  into adult male fish induced a dose-dependent accumulation of a 150 kDa plasma protein (EP). EP was detectable in Coomassie blue-stained polyacrylamide gels within 24 hours after injection of 2 mg hormone/ 100 g body wt. Electrophoretic mobility, peptide mapping, and immunological crossreactivity showed EP to be indistinguishable from a plasma protein in adult females with vitellogenic ovaries. Two major yolk polypeptides, YP1 (120 kDa) and YP2 (29.6 kDa) were acetone-precipitated from a yolk protein extract. YP1 but not YP2 reacted with anti-EP polyclonal antiserum in western blots. Peptide mapping after proteolysis with trypsin showed YPs 1 and 2 to be unique and revealed structural homologies between YP1 and EP. Liver but not pancreas explants from an estradiol-treated male synthesized and secreted a [35S]-methionine-labeled, 150 kDa protein in vitro. We tentatively conclude that EP and YP1 represent VG and LV, respectively. YP2 remains unidentified.

Supported by the Alabama NSF/EPSCoR Program in Molecular, Cellular and Developmental Biology (Grant #RII-8610669) and the Alabama Agricultural Experiment Station.

LARVAL GROWTH AND DEVELOPMENT OF ANURANS IN ARTIFICIALLY HEATED ENVIRONMENTS. David H. Nelson, Department of Biological Sciences, University of South Alabama, Mobile, AL. 36688

Larvae of the Southern leopard frog (Rana utricularia) reared in heated aquaria metamorphose more rapidly and at a smaller body size than those in unheated tanks. Field-collected specimens from a heated reservoir also develop more rapidly but reach a smaller body size than specimens in nearby unheated areas. Larvae of the Southern toad (Bufo terrestris) collected from a heated reservoir also demonstrate this same predictable pattern of growth and development. Some ecological problems of accelerated development and reduced growth are discussed. Apparent, thermally-induced developmental anomalies characteristic to amphibians are described.



HYMENOPTEROUS PARASITOIDS ASSOCIATED WITH OBSCURE SCALE, MELANASPIS OBSCURA (COMSTOCK), ATTACKING PIN OAK IN ALABAMA. H. J. Hendricks and M. L. Williams, Dept. of Entomol., Auburn University, AL 36849.

Although native to the Ohio Valley and Mid-Atlantic states, pin oak, Quercus palustris Muenchhausen, has become a popular shade tree in the South because of its pyramidal growth habit and red-to-bronze fall coloration. Introduction outside its natural distribution range and into Alabama's unfavorable growing conditions has resulted in an increased susceptibility to phytophagous insects, especially obscure scale, Melanaspis obscura (Comstock) (Homoptera: Diaspididae). The parasitoid complex associated with obscure scale attacking pin oak in Alabama was studied on 257 landscape plantings located on the Auburn University campus. Biweekly observations began in June of 1987 by sampling new growth terminals from each of the four cardinal compass directions from four randomly selected trees. Each sample was removed and placed in separate 1-quart cardboard containers with a 1-dram vial inserted into the side. Samples in these containers were then maintained in a Percival plant growth chamber for a two week period. Emerging adult parasitoids were attracted to the light in the vials where they were easily collected and recorded. Six species of Hymenoptera in the families Aphelinidae and Encyrtidae were collected. The aphelinids collected include, Encarsia berlesii (Howard), Azotus sp., and Encarsia sp. Collected encyrtids include, Ablerus clisiocampae (Ashmead), Coccophagoides fuscipennis (Girault), and Phycus varicornis (Howard). Coccophagoides fuscipennis represented 42% of the total parasitoids collected. Encarsia berlesii, A. clisiocampae, Azotus sp., and P. varicornis represented 25%, 23%, 6%, and 4% respectively.

HEAT STRESS PROTEINS IN ACHETA DOMESTICUS. Shannon E. Miculek and James T. Bradley, Dept. of Zoology and Wildlife Science, Auburn University, Auburn, AL 36849.

When an organism is exposed to high temperatures, it drastically increases production of heat stress proteins (hsp). This project examines hsp and hsp production in the fat body and ovary of the house cricket, Acheta domesticus, using radiolabeling with [35S]-methionine, SDS-PAGE, and fluorography. Three hsp with molecular weights of 89kD, 74kD, and 22kD were identified in both tissues.. Maximum production of these hsp occurred two hours after the temperature was elevated from the normal 27 C to 40 C. Other parameters, such as the onset and disappearance of hsp production at various temperatures in the two tissues were also investigated.

Supported by the Alabama/EPSCoR Program in Molecular, Cellular and Developmental Biology (Grant #RII-8610669) and the Alabama Agricultural Experiment Station.

AN ALTERNATE FEEDING METHOD IN THE GRAZING SNAIL, NERITINA RECLIVATA. Jacqueline M. Lane, Pensacola Junior College, Warrington Campus, Pensacola, FL 32507.

Although the brackish and freshwater snail, Neritina reclivata, feeds by non-selectively scraping periphyton from subtidal surfaces, it may also filter feed. The cilia on the foot of the animal create currents, and particles as small as bacteria are entrapped in the mucus secreted by the foot. The mucus-enveloped material is then transported to the anterior part of the foot by ciliary currents and licked (scraped) into the mouth. The animal remains motionless with its foot attached to substrate while filter-feeding. However, it may also catch material while suspended (artificially in the laboratory). This may also be the mechanism of capturing food while the snail is browsing over a muddy bottom. Using this type of feeding would allow the snail several distinct advantages: 1) high densities could be achieved without depleting a food source, and 2) the snail could remain in a "safe", place such as under a shell, without running out of food. This mechanism of feeding has not been reported for any gastropod before.

Mucus trails of this snail are also very efficient at trapping phytoplankton and growing blue-green algae and bacteria. However, there is no evidence that the snail uses the material grown or entrapped in its mucus trail for food.

EFFECTS OF CYTOKININ ON BRANCHING OF OKRA. James E. Brown, Gary J. Keever, and Marla C. Osborn. Department of Horticulture and Alabama Agricultural Experiment Station, Auburn University, AL 36849

Cytokinin (BA) rates of 0, 500, 1000, 1500 and 2000 ppm were each applied in 3 applications as foliar sprays to 'Clemson Spineless' okra. Pruning was included as an additional treatment. BA effectively retarded the height of okra, producing a quadratic growth response. The number of BA applications per treatment had no effect on the growth of okra. Crop yield (pod) was greatest from the control and decreased with increasing rates of BA. BA stimulated branching at the 1500 ppm rates; this was significant when compared to the control or pruned treatment. Preliminary results of this study suggest further investigation, focusing on the 1500 ppm rate for best branching response.

GRAM-NEGATIVE BACTERIAL SPECIES AS INDICATORS OF THE EFFECTS OF SEAFOOD PROCESSING WASTEWATER ON A SALTWATER MARSH. Richard F. Hulcher, AL Dept. of Environmental Management, 1751 Federal Drive, Montgomery, AL 36130 and Dr. Burke Brown, Univ. of South AL, Mobile, AL 36688

The long term effects of spraying seafood processing wastewater on a coastal saltwater marsh were investigated by examining the qualitative and quantitative differences of populations of gram-negative, facultatively anaerobic, heterotrophic bacterial species between control and treated experimental test plots. The test sprayings were conducted from August 1984, through December 1984. Sampling for bacterial characterization was performed during August 1985, November 1985 and April 1986. Enumerative data revealed no important differences in overall bacterial numbers between test plots over all sampling dates. Statistical analysis of group means and standard deviations for each individual test group and combination test group revealed important differences in intra-group and inter-group variability and species composition. Empirical analysis of qualitative data showed significant differences in specific attributes between test plots suggesting a shift in species diversity and population proportions. This was evidenced by the shift in percentage of gram-negative isolates from 33% in the control plots to 58% in the treated plots and by the trends in population percentage composition of the test plots when compared with the known reference isolates. Vibrio and Pseudomonas species were more prevalent in the treated plots. Over the course of this study, the percentage population of Vibrio species declined while the percentage population of Pseudomonas species increased. Also, as a group, treated plot isolates were more sensitive to antibiotics and were less viable at higher pH levels than the control plot isolates.

TANNINS AND THE FORAGING BEHAVIOR OF GRAY SQUIRRELS. Daureen Nesdill and A. Houston Williams, Dept. of Zoology and Wildlife Sciences, Auburn University, Auburn, AL 36849-5508.

Previous studies suggest that gray squirrels, Sciurus carolinensis, may reject acorns and hickory nuts on the basis of the tannin content of the nut. Tannins, which are astringent, may act as feeding deterrents by signaling to the squirrel the nutritional value of the nut. The present study investigated squirrel alternative uses of nuts (i.e., burial or ingestion) in relation to tannin content using two study sites. Mast trees present at Site 1 were predominantly Carya tomentosa and Quercus spp., while Site 2 consisted mainly of Quercus spp. and Pinus spp. Tannin content of nuts was determined and ranked as Quercus spp. > C. tomentosa > Pinus spp.. Nut usage data indicated that a greater percentage of acorns was buried than ingested. During early fall, while squirrels at Site 1 were ingesting nuts from C. tomentosa, squirrels at Site 2 were feeding on Pinus spp. seeds. These results suggest that squirrels may choose to ingest or bury nuts on the basis of tannin content.

EFFECT OF INDOMETHACIN ON THE CHANGES IN HEMOGLOBIN COMPONENTS IN ANEMIC RATS. Harold J. Spears and Mukul C. Datta, Dept. of Chemistry and Carver Research Foundation, Tuskegee University, Tuskegee, AL 36088.

Changes in hemoglobin (Hb) proportions toward newborn values are found to be a characteristic phenomenon in blood of acutely bled adult rats. An understanding of the mechanism of altering Hb components in adult life should aid in the development of cures for diseases like sickle cell anemia and thalassemia. This study was designed to examine the role of prostaglandins (PGs) in reversing Hb proportions toward newborn values in adult rats. Indomethacin was used for blocking PG synthesis during developing anemia in the rats. Hb components were separated by ion-exchange chromatography using a gradient of NaCl dissolved in glycine-KCN buffer. Indomethacin intake totally suppressed the changeover of Hb proportions toward newborn values in anemic rats. Changes in Hb proportions due to anemia were also blocked when indomethacin was replaced by acetylsalicylic acid (ASA).

Conditions	Hb Components(% of total) *	
	I + II + IV	V + VI + VIII
Control	36.0 ± 0.8	58.4 ± 0.7
Bled only	42.9 ± 1.5	51.3 ± 1.8
Bled + Indomethacin	36.7 ± 0.5	58.0 ± 0.9
Bled + ASA	36.5 ± 1.4	57.5 ± 0.9

\* Means ± SD, n = 6

Since both the drugs inhibit PG synthesis, the results point out that one or more prostaglandins are involved in the process of switching Hb components in adult life.

CHARACTERIZATION OF PROTEIN KINASE C GENE FAMILY. Marie W. Wooten, Dept. of Zoology/Wildlife, Auburn University, Auburn, AL 36849

Protein kinase C (PKC) is a phospholipid sensitive/calcium-dependent enzyme which phosphorylates ser/thr residues of target substrates. PKC is a member of a multigene family consisting of: Type I=gamma, Type II=beta 1,2, and Type III=alpha. Recently described isotypes in rat brain have been purified to homogeneity. Specific studies were conducted to investigate the various regulatory properties of these isotypes. These studies demonstrate specific requirements between isotypes for allosteric activators, calcium/phospholipid/phorbol ester. Examination of lymphocytes, fibroblasts, HL60, and pancreatic acinar cells demonstrate isotype specific expression. In addition, by production of antibodies to the beta-isoform an additional homologous kinase activity was detected. Studies are underway to characterize and clone the gene for this kinase. These data suggest that isotype activation and expression are an additional means of regulating signal transduction in a specific cell type.

CYTOCHEMICAL EFFECTS OF ETHREL ON ABSCISSION ZONES OF SOYBEAN PEDICELS. N. Suzanne Duchene, Curt M. Peterson, and Roland R. Dute, Dept. of Botany and Microbiology, Ala. Agric. Exp. Stn., Auburn University, AL 36849.

Ethrel, an ethylene releasing compound, promotes leaf and fruit abscission of many plant species. The influence of Ethrel on abscission was monitored in a controlled environment using excised racemes from field-grown IX93-100 soybeans. In all experiments, the first formed flowers or young pods and attached pedicels were removed. At each of the four distal nodes on the raceme, the flower or immature pod was excised leaving the pedicel attached to the rachis. Racemes were immersed in water (controls) or an aqueous .0001% Ethrel solution, aspirated, and then placed on a water-agar medium. Abscission zone pedicel tissue from this material was fixed at 0, 8, 24, and 30 hr, embedded in plastic, and observed using light and electron microscopy. Sections for light microscopy were stained with PAS and ABB to detect starch or protein. Only 3% of the untreated pedicels abscised after 30 hr compared to 75% abscission of Ethrel-treated pedicels. An abundance of starch grains was present in both untreated and treated abscission zones. There were fewer cell divisions in the Ethrel-treated abscission zones but more swelling of the primary cell walls, observable as early as 8 hr after treatment. Abscission of control pedicels was preceded by cell divisions in the abscission zone concomitant with wall breakdown at the middle lamella. Ethrel treatment rapidly stimulates pedicel abscission of excised soybean racemes.

INFLUENCE OF PACLOBUTRAZOL AND DAMINOZIDE ON PRODUCTION OF RADISH. Gary J. Keever, James E. Brown and Marla C. Osborn, Department of Horticulture and Alabama Agricultural Experiment Station, Auburn University, AL 36849

Paclobutrazol (PP333) rates of 0, 50, 100, 150 and 200 ppm were applied as foliar sprays to 'Scarlet Globe' radish. Daminozide (B-nine) at 3000 ppm was included as an additional treatment. Height of radish was quadratically suppressed by PP333. Root wet weight (linear response) was retarded with increasing rates of PP333, while leaf wet weight was not affected. Suppression occurred within 1 week of application and continued throughout the experiment. B-nine effectively suppressed radish top growth and response was similar to that induced by most rates of PP333. PP333 produced larger roots at low rates compared to the control and has the potential for producing greater root yield and profit.

GENOMIC CLONES ENCODING CHICKEN CARDIAC AND SKELETAL MUSCLE MYOSIN HEAVY CHAIN GENES. Abderrahmane Ould Sidya, Debra M. Moriarity, Holly E. Richter and Ronald B. Young, Dept. of Biological Sciences, University of Alabama in Huntsville, Huntsville, AL 35899.

Myosin, the major protein in muscle tissues, is a multisubunit protein composed of two heavy chains complexed with 2-4 light chains. The sarcomeric myosin heavy chain (MHC) exists as several different isoforms which are encoded by a multigene family in many species including rat, rabbit, chicken, bovine and human. The expression of the individual MHC genes is both tissue and developmental stage-specific. Although a high degree of sequence homology is known to exist among the coding regions of the MHC gene sequences, significant sequence divergence has been observed in the 3' and 5' flanking regions of these genes. We are using this divergence in the 3' non-coding regions of the genes to prepare isoform-specific DNA probes which can be used to further study the regulation of MHC gene expression. Fragments of approximately 700 base pairs in length were isolated from the 3' translated and untranslated regions of six different genomic clones. These fragments were radiolabeled and hybridized to dot blots of total RNA isolated from adult chicken ventricle, breast, thigh, brain, gizzard and liver tissues and from embryonic chick thigh and heart muscle. The results indicate that one of the clones is specific for a cardiac isoform of the MHC gene and another appears to be specific for the slow-twitch (skeletal red) isoform. The other four clones exhibit cross reactivity with RNA from several different tissues. (Supported by American Heart Assoc., Ala. Affiliate)

ECOLOGY OF THE BLACK BEAR IN ALABAMA. Julian L. Dusi, Dept. of Zoology and Wildlife Sciences, Auburn Univ., Auburn University, AL 36849. D. Tommy King, Dept. of Zoology and Wildlife Sciences, Auburn Univ., Auburn University, AL 36849.

The ecology of the black bear, Ursus americanus, in Alabama was studied in Hells Creek Swamp, northwest of Saraland, Mobile Co., Alabama. A population of about ten bears was present. Five were captured and radio-tagged, weighed, measured, and a premolar tooth taken for ageing. Home ranges were determined. Separate winter home ranges were determined to show the decrease in winter activity. Annual home ranges for four bears averaged 25.9km<sup>2</sup>. The greatest annual home range was 42km<sup>2</sup>. Winter home ranges for the same four bears averaged 0.93km<sup>2</sup>. Habitat was studied to determine its important factors. It contained many mast trees and a number of fruit producing shrubs. Acorns were the most important diet item. Ages of bears ranged from 2+ to 8 years. Support for the project was provided by the Alabama Department of Conservation and Natural Resources and the Alabama Agriculture Experiment Station.

COELOMIC TEMPERATURE, DESICCATION AND INTERTIDAL DISTRIBUTION OF PISASTER OCHRACEUS (ECHINODERMATA: ASTEROIDEA) DURING LOW-TIDE EXPOSURE. James B. McClintock, Dept. of Biology, Univ. of Ala. at Birmingham, Birmingham, AL 35294.

Coelomic temperature and percent total body-water loss were measured in the intertidal sea star Pisaster ochraceus over a low-tide in Monterey Bay, California. Distributions of body colors and sizes, distances above the zero-tide level, angle of attachment, activity levels and frequencies of occupation of protected microhabitats were ascertained for 128 individuals. Sea stars ( $\bar{X} R = 9.6 \pm 1.4$  cm;  $n = 12$ ) experienced a significant loss of total body water (6.5 - 19.6%) over an afternoon exposure, while coelomic body temperatures measured at 30 min intervals remained constant and significantly ( $P < 0.05$ ) lower than the adjacent substrata. Freshly-killed control individuals had coelomic temperatures similar to the substrata. There was a preference for attachment to steeply sloped substrata ( $60-90^\circ$ ) and no correlation between body color or body size and distance above the zero tide level or rates of dessication. All individuals remained inactive during low tide, and most (73%) occupied cracks, crevices, tidepools and algal canopies. Pisaster ochraceus appear to resist heat stress and desiccation through evaporative cooling, reduced activity and occupation of shaded microhabitats. I thank my students of Physiological Ecology (Moss Landing Marine Laboratory) for their assistance.

HIGHER GROUP CLASSIFICATION OF ADULT MALE SOFT SCALE INSECTS (HOMOPTERA: COCCIDAE). Gary L. Miller and Michael L. Williams, Department of Entomology, Auburn University, AL 36849-5413.

Of the approximate 90 species of soft scales in North America, only 10% of the adult males have been described. Identification and classification is based primarily upon adult female characteristics. Presently, adult male soft scales are placed into 5 natural groups: 1. The Coccus Group consisting of the genera Coccus, Ceroplastes, Parthenolecanium, and Pulvinaria; 2. The Eriopeltis Group containing Eriopeltis and Luzulaspis; 3. The Eulecanium Group including Filippia, Sphaerolecanium, Ctenochilton, Physokermes, and Eulecanium; 4. The Inglisia Group of the single genus Inglisia; and 5. The Toumeyella Group of Toumeyella, Pseudophilippia, and Neolecanium. All 5 groups are represented in North America. Morphological studies of the adult males of Philephedra tuberculosa Nakahara & Gill and Mesolecanium nigrofasciatum (Pergande) have resulted in their placement into the Eulecanium and the Toumeyella Group respectively. Utilization of adult males will further aid in classification of the entire family.

GUT CONTENTS OF CERATOPOGONID LARVAE. Lawrence J. Hribar and Gary R. Mullen, Department of Entomology, Auburn University, AL, 36849-5413.

Feeding behavior and food items are unknown for the larval stages of most species of biting midge larvae (Diptera: Ceratopogonidae). The presence of items in the alimentary canal of ceratopogonid larvae can be a good indicator of food items and feeding behavior. Slide-mounted larvae from the Auburn University Entomology Collection were examined microscopically at 1000X to determine gut contents. The percentage of larvae with discernable items in the gut among the four most numerous taxa examined ranged from 4% for Palpomyia spp. to 28% for Dasyhelea and Alluaudomyia spp. There were no discernable food items in the guts of Mallochohelea, Probezzia, or Sphaeromyias spp. Data were recorded as follows: taxon{total number of specimens examined}: food item(total larvae observed with that item). Alluaudomyia spp.[130]: pennate diatoms(19), oligochaete setae(8), rotifers(10), tardigrades(8), fungal spores(2), arthropod setae(1), filamentous algae(1), dipteran prolegs(1), desmids(1); Atrichopogon spp.[7]: pennate diatoms(1), filamentous algae(1); Bezzia spp.[174]: oligochaete setae(11), pennate diatoms(4), filamentous algae(1), insect tracheae(1); Culicoides furens[4]: pennate diatoms(1); Culicoides variipennis[25]: pennate diatoms(2); Dasyhelea spp.[109]: pennate diatoms(29), fungal mycelia(1), oligochaete setae(1); Forcipomyia spp.[15]: fungal hyphae(5), fungal spores(4), pennate diatoms(2); Leptoconops linleyi[5]: pennate diatoms(3), desmids(2); Palpomyia spp.[98]: pennate diatoms(4), fungal spores(2).

A MONOCLONAL ANTIBODY TO A SPERM SURFACE COMPONENT CAPABLE OF RECOGNIZING THE ZONA PELLUCIDA. Donna A. Free, R. Richardson, H. Boettger, S. Rushing, and G.R. Poirier, Dept. of Biology, Univ. of Ala. at Birmingham, Birmingham, AL 35294.

A monoclonal antibody, C-9, has been prepared to an epitope of a binding component (acceptor) present over the acrosomal cap region of murine spermatozoa. The acceptor site binds a proteinase inhibitor of seminal vesicle origin at ejaculation and participates in the in vitro binding of capacitated sperm to the zona pellucida. C-9 is an IgM molecule with a kappa light chain. It recognizes whole sperm, crude acceptor and affinity purified acceptor as determined by ELISA methodology. Indirect immunofluorescence shows that C-9 binds in the same region of the sperm head as does the inhibitor. Pretreating sperm with C-9 significantly reduces both zona and inhibitor binding; however, C-9 is still capable of recognizing sperm pretreated with inhibitor. Thus, the epitope recognized by C-9 is not directly involved with inhibitor binding. The epitope becomes fully expressed during epididymal maturation and remains intact during in vitro capacitation.



THERMAL MODULATION OF GROWTH IN THE STARFISH: POLYAMINES AND ORNITHINE DECARBOXYLASE. Stephen A. Watts, Dept. of Biology, Univ. of Ala. at Birmingham, UAB Station, Birmingham, AL 35294.

Along the coast of New Hampshire the northern sea star Asterias vulgaris is exposed to seasonal variations in temperature of  $-2^{\circ}\text{C}$  to  $+17^{\circ}\text{C}$ . A. vulgaris exhibits an annual reproductive cycle in which gonads increase slowly in size during the fall and winter and reach maximal size in the early spring. Historically, gonadal growth slows in the winter, and this decrease in growth has been attributed to low temperatures. In the sea star testis, the specific activity of ornithine decarboxylase (ODC, considered to be the rate-limiting enzyme in polyamine synthesis) increases in the fall during testicular growth, decreases in the winter and increases in the spring. Polyamine levels are correlated to changes in the activity of ODC. Kinetic studies indicate that ODC exhibits negative thermal modulation, i.e., the  $K_m$  of ornithine increases with a decrease in incubation temperature (0.22 mM to 0.65 mM at  $15^{\circ}\text{C}$  and  $0^{\circ}\text{C}$ , respectively).  $Q_{10}$  values are highest at low substrate concentrations and at low temperatures. We hypothesize that the decrease in hyperplastic growth of the testis during the winter is the result of 1) a decrease in the amount of ODC in the tissue and 2) a decrease in the affinity of the enzyme for the substrate as indicated by changes in the  $K_m$ . Furthermore, we suggest that thermal modulation of ODC (and polyamine synthesis) is a mechanism in which seasonal temperature fluctuations influence the seasonal patterns of growth of many ectothermal invertebrates.

EFFECTS OF PACLOBUTRAZOL AND GIBBERELIC ACID ON SWEET CORN. James E. Brown, Gary J. Keever, and Marla C. Osborn, Department of Horticulture and Alabama Agricultural Experiment Station, Auburn University, AL 36849

Paclobutrazol (PP333) rates of 0, 200, 400, 800 and 1600 ppm, and gibberellic acid ( $\text{GA}_3$ ) rates of 1000 and 2000 ppm were applied on 2 dates (38 and 56 days after planting) as foliar sprays to 'Sweet Belle' sweet corn. PP333 suppressed sweet corn height linearly with increasing concentration.  $\text{GA}_3$  at both rates compared to the control or PP333 (with the 2nd application date being most effective) accelerated sweet corn maturity by 6-8 days.  $\text{GA}_3$  suppressed ear length but promoted ear and stalk diameter. Manipulation of sweet corn growth characteristics with either growth regulator ( $\text{GA}_3$  or PP333) may provide a controlled maturation period. The ability of these regulators to accelerate or delay sweet corn maturity should allow for improved marketing strategies since time of harvest is a very critical factor in production.

PROSTAGLANDINS IN THE NEMATODE TRICHOSTRONGYLUS COLUBRIFORMIS, A PARASITE OF RUMINANTS. John C. Frandsen, USDA, ARS, Animal Parasite Research Laboratory, Auburn, AL 36831-0952.

Prostaglandins A<sub>2</sub>, E<sub>1</sub>, E<sub>2</sub>, 6-keto-F<sub>1a</sub>, and F<sub>2a</sub> were found via high-performance liquid chromatography (HPLC) in extracts prepared from the threadworm of ruminants, Trichostrongylus colubriformis. After removal from the intestine of the host goat, the worms were placed in 1mM indomethacin solution and then quickly frozen in acetone cooled by dry ice. At time of assay, they were homogenized at 0°C, the homogenate was acidified to a pH of less than 3, and the preparation was centrifuged in the cold to remove particulate material. The supernatant fluid was passed through a Waters C<sub>18</sub> SEP-PAK<sup>tm</sup> (previously activated with methanol) and the prostaglandins eluted with methylformate. After removal of the methylformate, this eluate was dissolved in an aqueous solution of acetonitrile, pH 2, and applied to a C<sub>18</sub> column developed with the same acetonitrile solution. Prostaglandins were identified via monitoring the absorbance of the eluate at 195 nm and comparing the resultant elution profiles with those of authentic standards. Though prostaglandins 6-keto-F<sub>1a</sub> and F<sub>2a</sub> were present in all extracts, the other prostaglandins were absent from some extracts, and there were great variations between extracts in the amounts recovered.

GENETIC VARIABILITY AND DEMOGRAPHIC CHARACTERISTICS OF THE AMERICAN LIVER FLUKE (FASCILOIDES MAGNA). Charles Lydeard, Dept. of Zoology and Wildlife Science, Auburn University, AL 36849. John M. Aho and Margaret Mulvey, Savannah River Ecology Laboratory, Aiken, SC 29801. Phyllis K. Kennedy, Dept. of Biology, Memphis State Univ., Memphis, TN 38152.

Demographic characteristics and genetic variability were examined in the American liver fluke, Fascioloides magna. Flukes were taken from deer livers collected during regularly scheduled hunts during the falls of 1985 and 1986 on the Savannah River Plant (SRP), Aiken, SC. SRP has a mosaic of habitat types representing bottomland hardwood and upland pine/oak forests. Both demographic and genetic characteristics varied among the 15 hunt areas examined. Fascioloides magna was found to have a highly aggregated distribution with prevalence and intensity related to habitat type. The results obtained from starch gel electrophoresis showed F. magna had levels of genetic variability similar to other parasites with multiple-host cycles. The interrelationships of host-parasite population structure and genetic variation will be discussed.

EFFECTS OF IN VITRO INCUBATION ON PROTEINASE INHIBITOR-ZONA PELLUCIDA BINDING SITES ON MURINE SPERM. Holly Boettger, R. Richardson, D. Free, S. Rushing and G.R. Poirier, Biology Dept., Univ. of Ala. at Birmingham, Birmingham, AL 35294.

Murine spermatozoa possess acceptor-type molecules localized on the plasma membrane over the acrosomal region of the sperm head. These sites are capable of binding a proteinase inhibitor of seminal vesicle origin and the egg zona pellucida. This presentation examines the binding characteristics of these sites during in vitro incubation in a medium known to support capacitation. Using the indirect immunofluorescence technique, eighty percent of cauda epididymal sperm showed positive acceptor fluorescence after two hours of incubation. A similar percentage of sperm were capable of binding inhibitor and exhibited intact acrosomes. Thus, these sites remained intact and functional throughout the incubation period. Sperm incubated in a capacitating medium and treated with solubilized zonae were unable to bind inhibitor. However, non-capacitating sperm treated with solubilized zonae retained their ability to bind seminal inhibitor. This suggests that incubation in a capacitating medium alters the acceptor sites, enabling them to bind zonae. These observations indicate that the acceptor sites, which are retained during in vitro incubation structurally and functionally intact, must be modified before they are able to bind zonae.

RESPIRATION OF GERYON FENNERI, A DEEP-WATER BENTHIC CRAB, IN NORMOXIA AND HYPOXIA. H. Handley, A. Krarup, H. Perry and R. Henry. Auburn Univ., AL, and Gulf Coast Research Lab., Miss.

G. fenneri were collected from depths of 400m or greater in wire mesh traps. Crabs were maintained at 5 C and 35 ppt salinity. Oxygen uptake ( $VO_2$ ), heart rate, scaphognathite frequency (fscaph) and branchial chamber pressure were measured in normoxia and hypoxia. Values in normoxia were 0.0031  $\mu\text{mol O}_2/\text{gm fr.wt.}\cdot\text{hr}$  ( $VO_2$ ), 28 bts/min (fscaph), -1 cm  $\text{H}_2\text{O}$  (branchial pressure) and 36 bts/min (heart rate). Ventilatory pauses occurred and were concurrent with cessation in heart beat. Scaphognathite reversals were observed but were not common. Normal  $VO_2$  rates were maintained in the face of hypoxia primarily through hyperventilation: fscaph increased up to 3-fold and branchial chamber pressure doubled. At a critical low  $\text{PO}_2$  of 20-30 torr ventilation and heart beat ceased, and  $VO_2$  fell to zero. Recovery in normoxia took 2-3 hr and was characterized by hyperventilation, tachycardia, and increased  $VO_2$ , presumably to repay an oxygen debt. Supported by NSF DCB 84-17379 and supplemental funds of the Research Experience for Undergraduates Program.

CHARACTERIZATION OF TWO VIRUS ISOLATES FROM TURNIP. Kleber A. Bajana and Robert T. Gudauskas, Dept. of Plant Pathology, Ala. Agric. Exper. Sta., Auburn Univ.. AL 36849.

Characterization studies were conducted leading to the identification of two virus isolates from diseased turnip plants (Brassica rapa L.) from experimental plantings at Tuskegee University, Ala. A host range study involving 33 species in seven families showed that all tested members of the Amaranthaceae, Chenopodiaceae, Asteraceae, and Brassicaceae were susceptible to the isolates, as were six of nine species in the Solanaceae and one of two species in the Cucurbitaceae. One of eight species tested in the Fabaceae developed symptoms, but the viruses were not recovered in back inoculations to susceptible hosts. The dilution end points, thermal inactivation points, and longevity in vitro for both isolates were similar to those reported for turnip mosaic virus (TuMV). Both isolates gave a positive cross-reaction with antiserum to TuMV in immunodiffusion tests and serologically specific electron microscopy (SSEM). SSEM and leaf dip preparations of both isolates showed long (680 nm), flexuous rod particles that were similar in size and shape to those of TuMV. Based on these studies of particle characteristics, serological relationships, stability, and host range and symptomatology, it was concluded that the isolates were strains of TuMV.

GENETIC VARIABILITY OF MOSQUITOFISH FROM SOUTHERN ALABAMA AND FLORIDA. Shelia B. Standbrough and Michael C. Wooten, Department of Zoology and Wildlife Science, Auburn University, Auburn AL 36849-5414.

The exact systematic status of mosquitofish from the southeastern United States has long been a source of contention among taxonomists. Populations in this area have undergone a series of taxonomic elevations and regressions with numerous species and subspecies designations being proposed. Recent studies utilizing allozyme data have added support to arguments that two distinct species of Gambusia exist in this area. Many studies have however recognized a zone of contact/hybridization within the rivers of south Alabama and northwest Florida. The purpose of this study was to examine this purported contact zone using allozyme data from starch gel electrophoresis. We tested at least 24 adult fish from each of 19 ample locations representing 9 drainage. Results from 13 variable loci indicated that fish from this region are distinct from populations of the neighboring species. Fish from these populations exhibited low levels of heterozygosity while maintaining expected Hardy-Weinberg proportions. These data are therefore inconsistent with a simple recurring hybridization model. Interpretations of these results in a regional perspective will be presented.

CALCULATING HOME RANGES: A NONPARAMETRIC APPROACH. J. Wanzer Drane, Depts. of Research Data Analysis, Al. Ag. Exp. Station and Botony and Microbiol., Sch. of Sci. and Math. Daureen Nesdill, Dept. of Zoology and Wildlife Science, Auburn Univ., Al 36849-5402

Recent papers estimating home ranges (HR) have assumed their data to have come from bivariate normal distributions. Another, estimating the focal centers of HRs claims the harmonic mean is invariant in respect to choice of origin and orientation of coordinate systems used. The first of these two is highly restrictive and the second is false. Here, we introduce bivariate distribution-free estimates of HRs. They are easy to compute, need no assumptions of either the normal or any other distribution, nor of elliptical regions, and all are totally invariant in respect to the choice of coordinate systems, their origins and orientations. They are, in fact, bivariate statistical tolerance regions.

ASPERGILLUS TERREUS--IS IT INVOLVED IN FESCUE TOXICOSIS IN CATTLE? Edward M. Clark, Dept. of Plant Pathology Auburn University, Auburn, Alabama 36849.

The incidence of Aspergillus terreus recovered from Acremonium coenophialum-infected and non-infected tall fescue grass and recovered from the rumens of heifers grazing on both kinds of grasses was determined. The recovery of Aspergillus terreus from the endophyte-infected grass was similar to that from the non-infected grass. Also the recovery of A. terreus from the rumens of the heifers on the two types of grasses showed no difference. All heifers on Acremonium coenophialum-infected grass showed symptoms of summer synarome while those on non-infected grass did not regardless of the status of Aspergillus terreus. Therefore A. terreus is not a factor in summer syndrome in cattle.

CASE REPORT: LIMA BEAN DIET PROMOTES URICOSURIC ACTION. Aaron B. Kendrick, retired, 4935 Eastern Valley Road, McCalla, AL 35111.

When 550 g of large dried lima beans were steam cooked with 1360 g of liver or sweetbreads, uric acid clearance was 24 cc/minute.

## Abstracts

### DEVELOPMENT OF A SUBUNIT VACCINE FOR CHANNEL CATFISH VIRUS.

M. A. Awad, Dept. of Fisheries and Allied Aquacultures, Auburn Univ., Auburn, AL 36849, K. E. Nusbaum, Department of Pathobiology, College of Veterinary Medicine, Auburn University, Auburn, AL 36849, and Y. J. Brady, Dept. of Fisheries and Allied Aquacultures, Auburn University, Auburn, AL 36849.

A wild strain of channel catfish virus (CCV) was treated with Triton (1X) to separate the viral envelope which was then prepared as a vaccine against channel catfish virus disease (CCVD). Four-day old channel catfish eggs and one-week old fry were vaccinated using the bath technique. The effect of single dose vs. booster vaccinations were also tested. The vaccinated fish were challenged with the same strain of CCV eight weeks after the first treatment. Egg treatment was not significant while fry vaccination gave about 80.7% survival. The protection from the booster vaccination proved more effective than from the single dose.

GOPHER TORTOISE POPULATION STRUCTURE IN CENTRAL MOBILE COUNTY, ALABAMA. John E. Marshall, Alabama Department of Environmental Management, Mobile Field Office, 2204 Perimeter Rd., Mobile, AL. 36615. David H. Nelson, Department of Biological Sciences, University of South Alabama, Mobile, AL. 36688.

Six colonies of the gopher tortoise (Gopherus polyphemus Daudin 1802) were surveyed in central Mobile County, Alabama. A total of 103 burrows were located and marked. The mean number of burrows per colony was 17.2 (SD=12.4, Range = 4-40), with 48 (46.6%) of the marked burrows considered active. The population was dominated by carapace length (CL) size-classes of 20.1cm (55%). Gopher tortoises in central Mobile County appear to be declining markedly.

PERMEABILITY AND MORPHOLOGICAL EFFECTS OF BACILLUS THURINGIENSIS TOXIN ON NEMATODE EGGS. Leon W. Bone, USDA, ARS, Animal Parasite Research Laboratory, Auburn, AL 36831-0952.

Toxins from strains of Bacillus thuringiensis are lethal to nematode eggs. The permeability of the egg may be altered by the toxin, based on the uptake of dye and a radiolabel. Morphological damage to the lipoidal layer of the eggshell was evident. Agents that affect membrane transport change the activity of the microbial toxin. Toxicity of selected strains of B. thuringiensis differed with various membrane transport agents which indicated strain-specific toxins.

BIOLOGY AND SEASONAL ABUNDANCE OF THE STRIPED EARWIG (LABIDURA RIPARIA) IN PEANUT FIELDS. Marwan S. Kharboutli and T. P. Mack, Dept. of Entomology, Alabama Agricultural Experiment Station, Auburn University, Auburn, AL 36849-5413.

The striped earwig, Labidura riparia (Pallas) is a highly abundant and an important arthropod predator in Alabama peanut fields. 500-ml pitfall traps, placed both on and between plant rows, and 0.91 m beat sheets were used to study seasonal abundance of the striped earwig in irrigated and unirrigated conventionally planted and tilled Florunner peanut fields at Headland, Al. It is nocturnally active and is a soil-dweller. Two male types were recorded; one similar to females in size and a larger one. Both types of males mate with females. Eggs are laid in the soil in groups, and the number of eggs laid varied between 50 to 95 eggs per clutch. Eggs incubated at  $26 \pm 1^{\circ}\text{C}$ ,  $70 \pm 5\%$  RH and a L:D regime of 14:10 hatched in ca. 9 days. Five nymphal instars developed to adults in ca. 35 days. A major peak of population occurred on the first week of August. Two other, but smaller, peaks were also observed in the middle of July and end of August. Irrigation had a positive effect on earwig abundance while trap location did not significantly affect abundance estimates.

SEASONAL DYNAMICS OF AN ALABAMA PINE VOLE POPULATION. Thomas V. Fleming and Ronald D. Gettinger, Department of Biology, University of Alabama at Birmingham, UAB Station, Birmingham, AL 35294.

Reproduction of pine voles in a north-central Alabama population has been examined in a continuing mark-recapture study. This population has been relatively stable since September, 1986 with an average minimum number known alive of 65 animals on our one hectare grid. Reproductive activity has been apparent in all sampling periods. Generally, a larger proportion of live-captured females than males was reproductively active. In addition to observation of live captures, necropsy data were collected from adult voles each sampling period. These data generally concurred with observations of live animals. Although there appeared to be no pattern to changes in ovarian mass, there were significant differences ( $p < .05$ ) among sampling periods. Pregnant females were present each month. Both testes mass and seminal vesicle mass varied seasonally with peaks in February, 1987 and September, 1987. Based on these observations, there appears to be no distinct breeding season in this species for this area. This work was funded in part by a grant from the Alabama Academy of Science.

GROWTH AND INOCULUM DENSITY RELATIONSHIPS IN THE BIOLOGICAL CONTROL OF RHIZOCTONIA SOLANI BY ANTAGONISTIC FUNGI. Robert T. Lartey and E. A. Curl, Dept. of Plant Pathology, and Curt M. Peterson, Dept. of Botany and Microbiology, Auburn University, AL 36849.

Competitive ability and the capacity of biological control agents to suppress soilborne plant pathogens and disease depend in part on growth rates of the contending organisms; higher inoculum densities of slow-growing agents may be required for effective control. Growth rates of three known biocontrol fungi, Trichoderma harzianum, Gliocladium virens, and Laetisaria arvalis, along with the cotton pathogen Rhizoctonia solani, were compared on common media (potato-dextrose agar, Czapek-Dox agar, and water agar) and in 1 x 44-cm glass tubes of sterilized soil. Mean colony growth of L. arvalis on the three media was most rapid of all the test fungi during the initial 36-hr period, but G. virens persisted over a longer period, making maximal growth in 60 hr. Growth rates of G. virens and R. solani were essentially equal, while T. harzianum was a relatively slow-growing organism. In tubes of sterile soil, G. virens grew most rapidly, L. arvalis and R. solani grew less rapidly but did not differ, and T. harzianum grew the least. Subsequent biocontrol tests showed that a high inoculum density of a specific control agent may not necessarily provide maximum suppression of a given inoculum density of R. solani or the related cotton seedling disease.

EFFECTS OF CHICKEN MANURE AND SOIL SOLARIZATION ON WEED CONTROL. James E. Brown, Michael G. Patterson, and Marla C. Osborn, Department of Horticulture and Department of Agronomy, and Alabama Agricultural Experiment Station, Auburn University, AL 36849

Effects of chicken manure and soil solarization (solar heating of soil using clear plastic during a summer period) on the control of morningglory (Ipomoea hederacea L.) and sicklepod (Cassia obtusifolia L.) weeds were investigated. Chicken manure was mixed with sterilized soil at the rate of 8 tons per acre. After planting weed seeds in the soil mix in 6-inch-wide, PVC pipe cylinders in field plots mid-June 1987, clear plastic film was placed over the drip-irrigated cylinders. Immediately following solarized periods of 2, 4, and 6 weeks, the film was removed and the weed species were planted and left to grow. Unsolarized soil mix controlled morningglory and sicklepod weeds by 41% and 49%, respectively; however, the solarized soil mix controlled both weed species by 100% after a 4-week period.



PRESENCE OF ESTROGEN RECEPTOR IN RAT SALIVARY GLAND. K.A. Swanson and P.S. Campbell, University of Alabama in Huntsville, Huntsville, AL 35899.

The presence of a specific, competable, and saturable estrogen binder in rat salivary gland tissue was determined by saturation analysis and steroid competition in cell-free homogenates of salivary gland tissue from ovariectomized females or intact males. The use of intact males was validated by experiments which excluded aromatization of endogenous androgens by the salivary gland. Scatchard analysis of the data indicated an estrogen receptor content of  $1971.1 \pm 651.4$  fM/gm tissue in female rat submandibular salivary gland. This was significantly greater ( $p < 0.01$ ) than that measured in the parotid gland ( $457.1 \pm 123.4$  fM/gm tissue). The submandibular gland of the male rat had a lower quantity of estrogen receptor ( $1307.8 \pm 294.5$  fM/gm tissue) than that measured in the female. Male parotid salivary gland had no measurable specific estrogen binding. Thus, there is a differential distribution in estrogen receptor content between parotid and submandibular salivary glands and between males and females. The presence of an estrogen receptor in salivary gland tissue (albeit low when compared to typical estrogen responsive tissues) may serve to mediate the reported gender differences in submandibular salivary gland EGF content as well as changes in saliva composition during the female reproductive cycle.

Supported in part by NSF Research Grant PCM-8409586.

REPRODUCTION OF VIRGINIA BUTTONWEED (*DIODIA VIRGINIANA* L.). Roland R. Dute, Dept. of Botany and Microbiology, Auburn Univ. Auburn, AL 36849-5407. James H. Baird, Crop and Soil Science Dept., Michigan State Univ., East Lansing MI. Ann E. Rushing and Ray Dickens, Depts. of Botany and Microbiology and Agronomy and Soils, Auburn University.

Buttonweed is a perennial plant of increasing importance in turf grass of Alabama. This study was completed to elucidate the ways in which buttonweed multiplies both vegetatively and reproductively. Large numbers of adventitious buds originate from tissue beneath the cork layer of the roots. These buds occur singly or in clusters and often are associated with lateral roots. Adventitious buds and associated roots also develop on the hypocotyls. Axillary buds on the aerial shoots represent yet another potential source of growth and branching. Floral reproduction occurs by open flowers on the aerial shoots, and by closed (cleistogamous), subterranean flowers borne on young shoots formed from the adventitious buds on the roots. The seeds formed by the underground flowers may represent a source of dormant, viable propagules that could germinate after soil disturbance. Thus, it appears as if a major reason for the success of buttonweed lies in its reproductive potential.

The Effects of Atrazine on RuDP Carboxylase in Rhodobacter sphaeroides  
Anna P. Reynolds and Alfred E. Brown, Dept. of Botany and  
 Microbiology, Auburn University, Auburn, AL 36849.

Previous work has shown that atrazine-resistant strains of Rhodobacter sphaeroides showed increased levels of carbon dioxide fixation in whole cell preparations when compared with the atrazine-sensitive wild type. In the present work, we report on the effects that atrazine has on the specific activity of ribulose-1,5-diphosphate carboxylase (RuDPC/O) in both resistant and sensitive strains of R. sphaeroides. In some resistant strains, the specific activity of this enzyme in cell extracts from atrazine grown cultures is elevated two-fold over non-atrazine grown cells which is consistent with the previous findings. However, in other resistant strains there is no significant change in its activity. The specific activity was also elevated in sensitive wild type cultures, even though the herbicide inhibits photosynthetic electron transport. In wild type cultures adapting to photosynthetic growth, the increase in specific activity of RuDPC/O was dependent upon light, and was stimulated by the presence of atrazine in the culture. The proteins in the sensitive and resistant cultures were analyzed by SDS-PAGE, which detected changes in a polypeptide that may correspond to the small subunit of RuDPC/O. A unique polypeptide was also found in wild type cultures grown in the presence of atrazine. These findings are discussed relative to the physiology of R. sphaeroides. This work was funded in part by the NSF-EPSCoR program to Auburn University.

BINDING OF LUTEINIZING HORMONE TO THE EPIDIDYMAL EPITHELIUM OF THE MOUSE. Caroline Adams and William Brumlow, Biology Department, Auburn University at Montgomery, Montgomery, AL 36193.

Luteinizing hormone (LH) binds to the Leydig cells of the rat and mouse testis where it stimulates steroidogenesis. In the present study, we used a standard immunoperoxidase technique to detect the binding of endogenous and exogenous LH to the epididymal epithelium of the mature mouse. Throughout the epididymal duct, a positive reaction for peroxidase, indicating LH binding, occurred in the Golgi area (Abe et al. Arch. histol. jap. 46:51, 1983) of principal cells. Occasionally a positive reaction was visualized in the region of the principal cells located between the Golgi area and the apical surface of the cells (supra-Golgi) and in the perinuclear area. In the corpus and cauda epididymidis, scattered entire principal cells were also positive. Throughout the epididymal duct, the reactions indicating the binding of exogenous LH were more intense than those of endogenous LH. The significance of LH binding to the epididymis is uncertain but may be related to steroidogenesis and steroid metabolism by the principal cells of the duct.

PREPARATION AND CHARACTERIZATION OF MONOCLONAL ANTIBODIES TO THE OUTER MEMBRANE PROTEINS OF SALMONELLA TYPHIMURIUM. Yvonne Upshaw, Lula Smith, Hiram Sims, Tariq Abdullah, Shukal Bala, and Shiva P. Singh, Biomedical Research & Training Program, Alabama State University, Montgomery, AL 36195.

The outer membrane (OM) of gram-negative bacteria contains pore-forming proteins or porins which facilitate the passive transport of small hydrophilic molecules (approx. 600 Da) across the membrane. Salmonella typhimurium LT-2 contains three such porins, OmpC, OmpF, and OmpD. In the present study, we sought to prepare and use a panel of monoclonal antibodies for the characterization of S. typhimurium OM proteins.

BALB/c mice were immunized with OmpC, OmpD and OM fragments and the draining lymph node cells were fused with P3x63-Ag.8.653 in the presence of polyethylene glycol. The hybridomas were selected in RPMI 1640 containing hypoxanthine-aminopterin-thymidine, and screened for antibody production by the enzyme-linked immunosorbent assay. The antibody producing hybridomas were cloned twice by the limiting-dilution technique. We recovered a total of 190, 123 and 19 clones specific for OM, OmpC, and OmpD proteins, respectively. The positive clones are currently being checked for specificity and cross-reactivity to porins and to other OM protein antigens by enzyme immunoassay and Western blot techniques. Preliminary results indicate that the OM specific hybrids cross-react with OmpF porin, however, there is very little cross-reactivity between OmpC or OmpD specific monoclonals with other porins.

THE INFLUENCE OF A CYTOKININ ON SOYBEAN PEDICEL ABSCISSION AND RACHIS ANATOMY. A. Kuang\*, C. M. Peterson, and R. R. Dute, Dept. of Botany and Microbiology, Alabama Agricultural Experiment Station, Auburn University, AL 36849-5407.

The cytokinin 6-benzylaminopurine (BAP) decreases pod abscission of soybean, Glycine max (L.) Herr. This study was performed to determine the effect of site and method of BAP application on both pedicel abscission and rachis anatomy of field-grown 'Tracy-M' plants. Pedicel abscission was recorded over a 5-day period, and histological changes in rachis anatomy were determined. Both location and method of BAP application influenced the timing of abscission. Spraying racemes with a BAP solution or applying BAP in lanolin to proximal nodes on a rachis where pedicels had been excised delayed pedicel abscission at more distal nodes. Swelling of the rachis due to an increase in both vascular tissue thickness and pith diameter occurred following BAP spray treatment, but only when pods were present at proximal nodes at the time of treatment. Rachis swelling following BAP treatment is dependent upon proximal pods, but BAP can delay pedicel abscission in their absence.

ALTERATIONS IN CAPRINE MUSCLE (MEAT) MORPHOLOGY AND MORPHOMETRY INDUCED BY VARIOUS COOKING PROTOCOLS. Victor M. Robbins, Carol S. Williams and John W. Williams. Department of Biology, Tuskegee University, Tuskegee AL 36088.

Goats represent an important potential source of income for small acreage farmers in the South, provided a viable market can be established. It is the purpose of this project to prepare selected commercial "cuts" of goat meat by several different cooking methods common in the South, evaluate muscle morphology and correlate this to product quality and consumer acceptance of the product. Samples of "ribs", "shoulder steak" and "hind leg or shank" steak were cooked either by dry or moist heat using either a conventional stove or microwave oven. In addition, samples were grilled over an open flame. Portions of each meat sample were observed by transmission and scanning electron microscopy, brightfield microscopy and Nomarski optics. Meats were evaluated for "tenderness" by a taste panel. Regardless of cooking method, decreased sarcomere lengths, increased muscle fiber fragmentation and disintegration of myofibrillar proteins, especially thin actin filaments in the I area were noted. Samples cooked with conventional heat (either moist or dry) showed a greater correlation between long sarcomere length and acceptable product tenderness. When viewed by TEM, microwave cooked samples displayed shorter sarcomeres than similar samples cooked by conventional heat. Sarcomere lengths in meat samples which were grilled over an open flame were longer in meat graded as "tender", shorter in "tough" meat. It is anticipated that these data can contribute to recipe development and recommendations, thus improving consumer acceptance of goat meat. Supported by USDA/CSRS Grant No. AL-X-HN-2.

WATER AND TEMPERATURE RELATIONS OF THE TERMITES COPTOTERMES FORMOSANUS SHIRAKI AND RETICULITERMES FLAVIPES KOLLAR. Ruth Sponsler and Arthur G. Appel, Dept. of Entomology, Auburn University, AL 36849.

Percentage total body water, rate of body water loss, and cuticular permeability were determined for the Formosan subterranean termite, Coptotermes formosanus Shiraki and for the Eastern subterranean termite, Reticulitermes flavipes Kollar. Cuticular permeability ranged from  $15.22 \mu\text{g}/\text{cm}^2/\text{h}/\text{mmHg}$  for C. formosanus soldiers to  $37.49 \mu\text{g}/\text{cm}^2/\text{h}/\text{mmHg}$  for C. formosanus workers. Critical thermal maxima and upper lethal limits of C. formosanus were higher than those of R. flavipes. A two-factor factorial randomized complete block design with species and stage (worker or soldier) was used in analysis of temperature tolerance data. Lower lethal limits of C. formosanus and R. flavipes were not significantly different.

PARTIAL CHARACTERIZATION OF TETRAHYMENA PYRIFORMIS CILIARY MEMBRANES. B. H. Estridge & C. A. Sundermann. Dept. Zoology & Wildlife Science, Auburn University, AL 36849.

Cilia of Tetrahymena pyriformis, a hymenostome ciliate, were isolated by 3 methods--shearing, ethanol, and dibucaine--and examined by light (LM) and transmission electron microscopy (TEM) and SDS-PAGE (gel electrophoresis). LM revealed that somatic, but not oral, cilia were detached by all 3 methods; deciliated cells were viable after shearing but not after ethanol and dibucaine treatments; dibucaine caused membrane damage (swelling). TEM revealed that cilia were intact after shearing and dibucaine treatments; ethanol-treated cilia preps contained some demembranated axonemes. Over 50 polypeptide bands were visualized with SDS-PAGE of whole cilia, including 2 large bands of 53 kD MW and 55 kD (MW of tubulins) and a large band > 200 kD; polypeptide bands of sheared and ethanol-treated cilia were similar but several differences were seen in dibucaine-treated cilia. Ciliary membranes were isolated from sheared cilia by treatment with low ionic strength Tris-EDTA and ultracentrifugation on a sucrose step gradient. Two bands layered at distinct points on the gradient and were collected and analyzed by TEM and SDS-PAGE. Fraction 1 (F1) consisted of membrane vesicles of heterogeneous size, many were multilamellar; fraction 2 (F2) consisted of completely and partially demembranated axonemes. In SDS-PAGE, F1 contained small amounts of polypeptides of the size of tubulin, and a large band of 42 kD. F2 had a complex pattern of polypeptides similar to whole cilia. These procedures produce a pure source of cilia and concentrated ciliary membrane for use in studies of surface membrane protein interactions. Supported by NSF/EPSCoR.

COMMUNITY STRUCTURE OF AN HALODULE WRIGHTII HABITAT IN ALABAMA. Ann Houston Williams, Loren D. Coen, Tara A. Kerwin, and Christopher P. Welsh, Dept. of Zoology and Wildlife Science, Auburn Univ., AL 36849 and Dauphin Island Sea Lab., Dauphin Island, AL 36528.

Macrofaunal species were sampled by suction dredge along a vegetational gradient (high density grass vs. low density grass) and in an adjacent unvegetated soft bottom habitat from July to December 1987. Three mollusc species (Anomalocardia auberiana, Mitrella lunata, and Diastoma varium) exhibited relatively high densities in unvegetated habitat as compared to vegetated areas. Eleven species' densities were significantly different between vegetation levels or between vegetated and unvegetated bottoms. Differences in mean sizes of some species (e.g., Callinectes sapidus) indicate differential use or mortality of size classes within differing vegetation levels. Recruitment of blue crabs was extremely high in September with no apparent preference for vegetational density indicated by individuals of < 5 mm carapace width.

NEW MODES OF TRANSMISSION OF CARYOSPORA BIGENETICA (APICOMPLEXA: EIMERIIDAE). R. J. Douglas, C. A. Sundermann, Dept. Zoology & Wildlife Science, Auburn University AL, 36849, D. S. Lindsay, USDA, Animal Parasitology Inst., Beltsville, MD

Transmission of C. bigenetica between different species of rodents by cannibalism was demonstrated. A cotton rat was inoculated orally with a mixture of 150,000 oocysts/sporocysts of C. bigenetica. These oocysts had been obtained from the feces of a canebrake rattlesnake. Sixteen days after inoculation (DPI), this rat was killed and portions of the face and scrotum were fed to a rat and a mouse. Seventeen days later, this mouse was killed and fed to two mice. All animals in this study were infected with C. bigenetica as evidenced by the presence of caryocysts in fresh smears of facial and scrotal tissue. In a second study, route of inoculation vs site of infection was investigated. Seven groups with 3 mice each were inoculated with oocysts and sporocysts by one of these routes: orally, intra-peritoneally, subcutaneously, intra-venously, intra-muscularly, intra-ocularly, dermally. Nine DPI all mice displayed clinical signs of dermal coccidiosis i.e., swollen nose and muzzle. At necropsy, 10 DPI, a mouse from each group had gamonts or immature oocysts present in 3 or more of the following locations: tongue, muzzle, footpad, eye, conjunctiva, dorsal dermis, thigh muscle. Thirteen DPI, caryocysts were present in these tissues in mice sacrificed from each group. It appears that route of inoculation has little influence on the final site of development of Caryospora bigenetica.

LESSER CORNSTALK BORER DAMAGE TO PEANUTS. T.P. Mack, I. D. Buckelew, and C. M. Peterson, Department of Entomology and Department of Botany, Alabama Agricultural Experiment Station, Auburn University, AL 36849-5413.

Lesser cornstalk borer, Elasmopalpus lignosellus (Zeller) (Lepidoptera: Pyralidae) damage to Florunner peanut root crowns and to lower stems was estimated by planimetric methods after cross sectioning damaged stems. Eight 5-10 mm lesser cornstalk borer larvae were placed on each greenhouse reared, 11 node tall peanut plant. Mean percent damage to the epidermis and cortex was 24.12%, to phloem was 14.18%, and to xylem was 0.34%. In a separate study, pod and seed dry weight was reduced by ca. 6% by each lesser cornstalk borer larva completing development on a plant. Thus, nutrient transport and root growth within the peanut plant are affected by lesser cornstalk borer feeding on the root crown area.

EXPERIMENTAL INFECTIONS AND ULTRASTRUCTURE OF CARYOSPORA BIGENETICA IN COTTON RATS. C. A. Sundermann, D. S. Lindsay\* & B. L. Blagburn, Dept. Zoology & Wildlife Science, Dept. Pathobiology, Auburn University AL, 36849 & \*USDA, Animal Parasitology Inst., Beltsville, MD 20705.

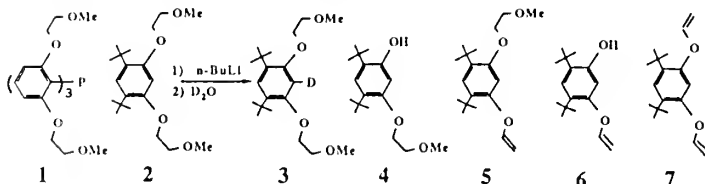
Experimental infections of C. bigenetica were initiated in cotton rats by oral inoculation of either 800,000 oocysts + 800,000 sporocysts (high dose) or 400,000 oocysts + 300,000 sporocysts (low dose). Oocysts were isolated from the feces of an eastern diamondback rattlesnake. All males in the high dose group displayed swollen scrota and faces 8 days post-inoculation (DPI) and died beginning 10 DPI. Five of 8 males in the low dose group died 9-12 DPI. All rats displayed clinical signs of infection. Females in both groups had swollen ears with lesions. The presence of C. bigenetica in various tissues of all rats was confirmed by examination of histological sections and fresh smears. At the ultrastructural level, fully formed merozoites with typical coccidian apical complexes and various stages of merogony were seen in facial tissues taken 10 DPI. Host cells were macrophage-like and often multiply infected. Numerous gamonts were present 12 DPI and possessed typical apicomplexan ultrastructural features. Partially sporulated oocysts were present in ear tissue sampled 14 DPI. These oocysts had a very thin wall and contained small lipid bodies and amylopectin granules. Caryocysts (16 DPI) consisted of a spherical host cell surrounded by a thick, fibrous layer. Each caryocyst contained 1 or more sporozoites free in the cytoplasm or within a parasitophorous vacuole.

HATCHING SUCCESS AND NESTLING SURVIVORSHIP STUDIES IN AN ALABAMA CATTLE EGRET ROOKERY. Georganna S. Ranglack and Ken R. Marion, Biology Dept., Univ. of Alabama at Birmingham, Birmingham, AL 35294.

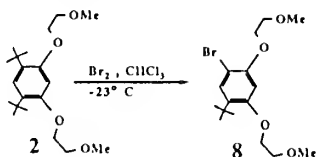
Factors influencing hatching success and nestling survivorship in a large mixed-species heron rookery in Alabama were studied for four seasons. Cattle egrets (Bubulcus ibis) comprised more than 90% of the nesting population. Hatching success and nestling survivorship of cattle egrets varied between years, but not dramatically so. Annual hatching success ranged from 60% to 75%. Nestling survivorship to approximately two weeks of age averaged 65%. Preliminary analyses indicate that nests established on the peripheral areas of the colony had similar success rates as those established in central areas. Eggs laid in nests established late in the season had a lower hatching success rate when compared to those laid during the major nesting period. Nestling mortality increased during extended wet periods.

ORTHO-LITHIATION OF (2-METHOXYETHOXY)-SUBSTITUTED AROMATICS. P. Livant, Jian-Hua Mao, Dept. of Chemistry, Auburn University, AL 36849-5312.

Studies directed toward the synthesis of **1**, a novel ionophore, are described. The crucial step in the synthesis is metalation at the 2-position of 4,6-di-*tert*-butylresorcinol bis(2-methoxyethyl)ether, **2**. The outcome of lithiation of **2** was monitored by quenching with D<sub>2</sub>O. Products **3** - **7** have been identified



unambiguously and their yields determined under a variety of reaction conditions, including the use of the bases LDA and MeLi, various solvents and reaction temperatures. Total yield of side-products **4** - **7** ranged from 13 to 83% based on the amount of **2** reacted. Bromination of **2** was expected to occur at the 2-position. Remarkably, it was found that bromination of **2** gives exclusively **8**, even at -23 C. (!)



PREPARATION AND REACTIONS OF FLUOROPHOSPHONIUM IONS.

M.A. Salam Biswas and W.E. Hill, Department of Chemistry, Auburn University, Auburn University, AL 36849

Fluorophosphonium ions have been prepared by the reaction (CH<sub>3</sub>)<sub>2</sub>NPF<sub>2</sub> and [(CH<sub>3</sub>)<sub>2</sub>N]<sub>2</sub>PF with alkylating agents. Identical fluorophosphonium salts were obtained with a particular alkylating agent from either aminophosphine. The products were characterized by <sup>1</sup>H, <sup>31</sup>P and <sup>19</sup>F NMR, IR and mass spectrometry. Mechanisms for the formation of the salts are proposed. Hydrolysis of the fluorophosphonium salts was carried out to give alkylphosphonofluoridate(1-). This ion hydrolyses further to give alkylphosphoric acids and fluoride ion but this reaction is extremely slow. A mechanism is postulated for the hydrolysis reaction.

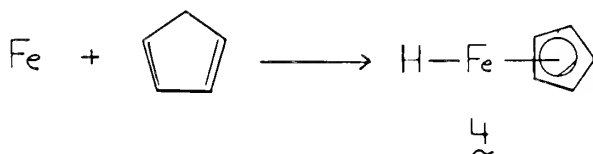


## TRAPPING OF CYCLOPENTADIENYLIRON HYDRIDE IN THE

COCONDENSATION OF IRON ATOMS WITH CYCLOPENTADIENE. R. D.

Cantrell and P.B. Shevlin, Department of Chemistry, Auburn University, Auburn University, AL 36849

The cocondensation of iron atoms with cyclopentadiene at 77K and the subsequent addition of carbon monoxide yields  $\text{Fe}(\eta^5\text{-C}_5\text{H}_5)_2$ , 1,  $\text{Fe}_2(\eta^5\text{-C}_5\text{H}_5)_2(\text{CO})_4$ , 2, and  $(\eta^5\text{-C}_5\text{H}_5)\text{Fe}(\text{CO})_2(\eta^5\text{-C}_5\text{H}_5)$ , 3. The products are postulated to arise via an initial insertion of an iron atom into a C-H bond of cyclopentadiene to give cyclopentadienyliron hydride, 4. Intermediate 4 then reacts with cyclopentadiene to give 1. The trapping of intermediate 4 with carbon monoxide yields the hydride  $\text{HFe}(\text{CO})_2(\eta^5\text{-C}_5\text{H}_5)$ , 5. Intermediate 5 then dimerizes to give 2 or reacts with cyclopentadiene to give 3.



IR AND UV SPECTRA AS A PROBE OF BONDING IN CHROMIUM COMPLEXES. J. Rawlings, C.A.L. Mahaffy, and M.C. Reid, Department of Chemistry, Auburn University at Montgomery, Montgomery, AL 36193.

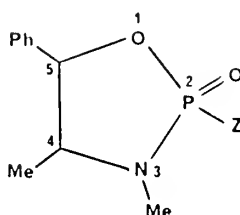
Force constants for the carbonyl stretching frequency for a wide variety of substituted arenetricarbonylchromium complexes have been obtained. These force constants have then been correlated with several different kinds of Hammett or Taft substituent parameters. These parameters reflect the differing mechanisms by which a substituent can influence the arene ring, and thereby, with transmission through the chromium, affect the electron density and force constant of the carbonyl group. A preferred mechanism is indicated by a high correlation with  $\sigma_p$ . Investigations of the substituent effect on the electronic spectra have been performed in a similar fashion.

## CONFORMATIONAL ANALYSIS OF 1,3,2-OXAZAPHOSPHOLANES

DERIVED FROM EPHEDRINE AND PSEUDOEPHEDRINE

Barry G. Black and William N. Setzer, Department of Chemistry,  
The University of Alabama in Huntsville, Huntsville, AL 35899.

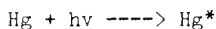
A series of 1,3,2-oxazaphospholanes has been prepared and studied conformationally using proton NMR spectroscopy at 200 MHz. The NMR data are best interpreted in terms of conformational equilibria involving twist-envelope conformations. The conformational preferences are such that small electronegative substituents on phosphorus prefer a pseudoaxial position whereas bulky phosphorus substituents prefer pseudoequatorial positions in these equilibria.



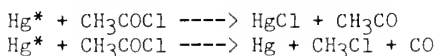
We thank the Donors of the Petroleum Research Fund administered by the American Chemical Society for support of this work.

PHOTOSENSITIZED DECOMPOSITION OF ACETYL CHLORIDE. Iyabode M. Olayiwola, and P. S. Gill, Dept. of Chemistry, Tuskegee Univ. Tuskegee, AL 36088

The photosensitization of compounds containing carbonyl groups is frequently followed by decomposition which may take place by a molecular or a radical process. The first stage in this sequence is the absorption of a quantum of light by mercury with the formation of an activated atom.



The excited mercury atom then transfers the energy to the molecule on collision thereby activating it for the reaction. We have observed the photosensitized decomposition of acetyl chloride at room temperature with a low pressure mercury lamp. The products can be explained by the following sequence of reactions.



SYNTHETIC APPROACHES TO N-PHENYLPYRROLO-3,4-DICARBOXYLIC ACIDS AND PYRROLO[1,2-a]QUINOLINES. Jack DeRuiter, Department of Pharmacal Sciences, School of Pharmacy, Auburn University, AL 36849.

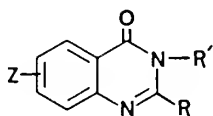
A variety of N-phenylpyrrolo-3,4-dicarboxylic acids 1 and pyrrolo-[1,2-a]quinolines 2 were synthesized as potential DNA alkylating agents and enzyme inhibitors. Derivatives of 1 were obtained in a multi-step reaction sequence starting with substituted anilines. Treatment of anilines with acetic anhydride afforded the intermediate acetanilides which were N-alkylated with ethyl 2-bromopropionate. The alkylated intermediates were hydrolyzed to the corresponding N-acetyl-N-arylglycines under basic conditions. The alanine intermediates were then treated with acetic anhydride and dimethyl acetylene dicarboxylate which resulted in cyclodehydration followed by 1,3-dipolar cycloaddition to yield the N-phenylpyrrolo-3,4-dicarboxylate esters. These esters were converted to the diacids with base-catalyzed hydrolysis or converted to the bis hydroxymethylene carbamates upon reduction with lithium aluminum hydride followed by treatment with alkyl isocyanides. The pyrrolo[1,2-a]quinolines 2 were synthesized by performing the cyclodehydration/cycloaddition sequence with 2-oxoquinoline-1-alkanoic acids. Alternatively these tricycles were prepared by cycloaddition reactions with Reissert fluoroborate salts. The Reissert intermediates required for these reactions were obtained by reaction of quinolines with trimethylsilylcyanide and acetyl chloride in the presence of a catalytic amount of aluminum chloride.

**REACTION OF UREA FORMALDEHYDE CONDENSATION PRODUCTS WITH AMMONIA.** J. Larry Morris and Thomas P. Murray. Department of Chemistry, University of North Alabama, Florence, Alabama 35630.

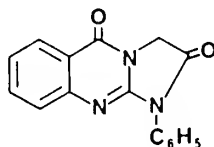
The reaction of anhydrous ammonia with dimethylolurea under mild conditions has been shown to give a quantitative yield of the macrocyclic ether 4,8-dioxo-1,7,3,5,9,11-dioxatetraazacyclododecane. Study of this reaction has continued, using more stringent conditions and a variety of methylene and methylol ureas as starting materials. Anhydrous ammonia under conditions of elevated temperature and pressure has been found to be an effective reagent for reversal of methylolurea formation with concomitant formation of hexamethylenetetramine. The same reaction, however, is not effective in reversing methylene urea formation. Results on the ammoniation of a variety of methylol and methylene ureas will be presented.

SYNTHESIS OF 2- AND 3-SUBSTITUTED QUINAZOLIN-4-ONES AND IMIDAZO-QUINAZOLINONES. Jack DeRuiter and Thomas N. Riley, Department of Pharmacal Sciences, School of Pharmacy, Auburn University, AL 36849.

A number of 2- and 3-substituted quinazolin-4-ones were synthesized as potential CNS depressants. The 3-arylquinazolinones were prepared from anthranilic acid in a reaction sequence involving cyclodehydration ( $\text{POCl}_3$ ) followed by treatment with an aniline derivative. Also, several 3-alkyl quinazolinones were synthesized by alkylation of quinazolinone which was prepared by treatment of anthranilic acid with formamide at high temperature. A variety of 2-arylaminquinazolin-4-ones were synthesized by a four step reaction sequence. Reaction of anthranilic acid with  $\text{KOCN}$  provided quinazolin-2,4-dione which was converted to the 2,4-dichloro quinazoline upon treatment with phosphorus oxychloride. Selective hydrolysis of the dichloro intermediate afforded 2-chloroquinazolin-4-one. The 2-arylaminquinazolin-4-ones were then obtained by displacement reactions with the 2-chloro intermediate and substituted anilines. Imidazoquinazolinone was synthesized by N-alkylation of 2-chloroquinazolin-4-one with ethyl bromoacetate, followed by displacement and cyclization with aniline.



Substituted Quinazolin-4-ones



Imidazoquinazolinone

TETRAKIS-( $\mu$ -DIFLUOROACETATO)DIMOLYBDENUM(II): SOLUTION CHEMISTRY AND MASS SPECTRUM. Thomas R. Webb, James D. Pollard, George W. Goodloe, and Michael L. McKee, Dept. of Chemistry, Auburn University, AL 36849.

The solution chemistry of  $\text{Mo}_2(\text{O}_2\text{CCHF}_2)_4$  has been investigated by  $^{19}\text{F}$ -nmr and electronic spectroscopy. The complex exists as the axial adduct in acetone solution. An axial and a monoequatorial adduct are in equilibrium in pyridine solution; at low temperatures, the axial adduct is the major species (3:2). Three adducts (axial, monoequatorial, and diequatorial) are present when tributylphosphine is added to an acetone solution of the complex. With a  $\text{P}:\text{Mo}_2$  ratio of 2:1, these adducts are present in ca. a 2:1:2 ratio at low temperature. When more tributylphosphine is added, the axial adduct is converted to equatorial adducts. These results indicate that the difluoroacetate is less prone to equatorial adduct formation than is the corresponding trifluoroacetate.

The mass spectrum of  $\text{Mo}_2(\text{O}_2\text{CCHF}_2)_4$  has been determined. Major fragmentation pathways involve the loss of F and  $\text{CHFCO}_2$ .

INTERACTION OF CO AND NH<sub>3</sub> ON SUPPORTED Pd-CATALYSTS.

Dilip K. Paul and Shelby D. Worley, Department of Chemistry, Auburn University, Auburn University, AL 36849-5312

The interaction of CO and NH<sub>3</sub> adsorbed on Al<sub>2</sub>O<sub>3</sub>, SiO<sub>2</sub> and TiO<sub>2</sub> supported Pd has been studied by using FT infrared spectroscopy. On all supported catalysts (pretreated with oxygen) adsorption of CO and NH<sub>3</sub> produces an isocyanate species under different conditions, i.e. on Al<sub>2</sub>O<sub>3</sub> supported Pd at room temperature, and on SiO<sub>2</sub> and TiO<sub>2</sub> supported Pd while cooling the cell down to room temperature after heating the reacting gases (CO & NH<sub>3</sub>) at high temperature. The assignment of the isocyanate species were confirmed using isotopically labeled compounds and by chemisorbing HNCO (isocyanic acid) on catalytic surfaces. On the Pd/TiO<sub>2</sub> surface, formation of CH<sub>4</sub> was also observed. In order to understand the mechanism of formation of isocyanate, decomposition of formamide was also studied under reaction conditions. Isocyanate formed with great ease on Pd/Al<sub>2</sub>O<sub>3</sub>, whereas its formation on other catalysts, particularly Pd/TiO<sub>2</sub>, was much slower. The NCO groups present on Pd/SiO<sub>2</sub> at 2170-2180 cm<sup>-1</sup> give an indication of the presence of a Pd-NCO species rather than NCO adsorbed on the SiO<sub>2</sub> support. Thus, isocyanate formed from the CO and NH<sub>3</sub> reaction on Pd/SiO<sub>2</sub> does not spill over from Pd microcrystallites on to the support, but formed from HCONH<sub>2</sub> decomposition, it migrates to the support as characterized by a Si-NCO band at 2290-2300 cm<sup>-1</sup>. Once formed, the Si-NCO groups are quite stable and are not readily decomposed.

EVALUATION OF CHEMISTRY LABORATORY STUDENTS. Raymond E. Isbell, Ph.D., Department of Chemistry, University of North Alabama, Florence, Alabama 35632.

The Department of Chemistry and Industrial Hygiene of the University of North Alabama recently separated each chemistry laboratory course into two courses, a lecture course, and a laboratory course. This separation has had several good effects but it has required some adjustments. The grading system and our inability to continue to use the laboratory as a crutch to overcome a poor performance on the lecture examinations. This paper describes a method of teaching and evaluation in the laboratory which is believed to be effective in motivating students both to learn more and achieve better grades.

SYNTHESIS OF SUBSTITUTED N-ARYLSULFONYLAMINO ACIDS AS POTENTIAL ENZYME INHIBITORS. Charles A. Mayfield and Jack DeRuiter, Department of Pharmacal Sciences, School of Pharmacy, Auburn University, AL 36849

A number of N-,  $\alpha$ -, and ring substituted arylsulfonylamino acids were synthesized as potential inhibitors of the enzyme aldose reductase. Simple ring substituted N-phenylsulfonyl glycines, alanines, sarcosines, prolines and  $\alpha$ -phenylglycines were prepared directly by reaction of arylsulfonyl chlorides with the appropriate amino acid in aqueous base. Catalytic reduction of the nitro derivative of 1 ( $R = NO_2$ ) provided the amino analogue ( $R = NH_2$ ) which was functionalized by acylation with aroyl chlorides (to give 2), alkyl chloroformates, isocyanates and isothiocyanates and reductive alkylation with formaldehyde and benzaldehyde in the presence of sodium cyanoborohydride. Also, a more versatile approach for the synthesis of analogues of 2 with varied N- and  $\alpha$ -substituents was developed involving chlorosulfonation of benzanilide followed by treatment with a N- or  $\alpha$ -substituted glycine derivative. N-aryl-N-arylsulfonylglycines 3 were obtained by two routes. The first method involved alkylation of N-arylsulfonamides with ethyl bromoacetate, followed by base-catalyzed hydrolysis of the intermediate esters. Alternatively, derivatives of 3 were synthesized by treatment of N-arylglycines with arylsulfonyl chlorides; the N-arylglycines were prepared by alkylation of anilines with chloroacetic acid. While this latter route is more direct, lower overall yields were obtained. The synthetic approaches to other N-arylsulfonylamino acids as well as chemical reactivity studies will be presented.

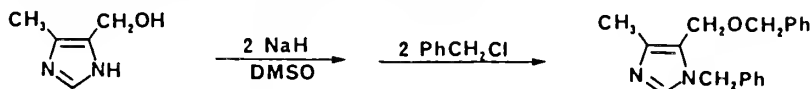
THE REACTIVITY OF P-P BONDED SYSTEMS TOWARD AMINOARSINES. Dileep K. Srivastava, L. K. Krannich and C. L. Watkins, Dept. of Chemistry, Univ. of Ala. at Birmingham, Birmingham, AL 35294.

The reactions of  $R_2PPR_2$  ( $R = Me, Et, Ph$ ) and  $(MeP)_5$  with  $Me_{3-n}As(NMe_2)_n$  ( $n = 1, 2, 3$ ) and of  $Me_2PPMe_2$  with  $Me_2AsNR'_2$  ( $R' = Et, n-Pr$ , and  $i-Pr$ ) were investigated as a function of time at room temperature using  $^1H$  and  $^{31}P$  NMR spectroscopy. For the diphosphine/ $Me_2AsNR'_2$  reactions, the NMR spectral data suggest a reaction pathway involving the initial formation of  $R_2PAsMe_2$  and the respective acyclic dialkylaminophosphine,  $R_2PNR'_2$ . The P-As intermediate then symmetrizes to  $R_2PPR_2$  and  $Me_2AsAsMe_2$ , the parent aminoarsine is completely consumed, and an additional  $R_2PNR'_2$  is formed. The relative rate of aminophosphine production is dependent upon the nature of the substituent on the phosphorus and nitrogen atoms. For systems involving  $MeAs(NMe_2)_2$  and  $As(NMe_2)_3$  as reactants, the intermediates could not be characterized, but the products were the expected aminophosphine and  $(MeAs)_5$  or elemental arsenic, respectively.  $(MeP)_5$  reacts to give  $MeP(NMe_2)_2$  and the expected As-As bonded species. The results of the NMR study were utilized in designing a convenient, high yield, synthetic route to acyclic aminophosphines.

ELECTROPHILIC AROMATIC SUBSTITUTION REACTIONS  
WITH SUBSTITUTED IMIDAZOLES

Kelly G. Locklar, William N. Setzer, Cynthia A. Howell, and June Kalange, Department of Chemistry, The University of Alabama in Huntsville, Huntsville, AL 35899.

4-Methyl-5-imidazolemethanol has been benzylated using sodium hydride and benzyl chloride in dimethylsulfoxide:



The benzylated imidazole was studied in terms of its reactivity toward electrophilic aromatic substitution reactions. Nitration ( $\text{HNO}_3/\text{H}_2\text{SO}_4$ ), bromination ( $\text{Br}_2/\text{CHCl}_3$ ), and chloromethylation ( $\text{H}_2\text{CO}/\text{HCl}$ ) were carried out in an attempt to prepare the 2-substituted imidazole derivatives.



Support of this work by the National Institutes of Health (Grant Number 1 R15 GM37488-01) is gratefully acknowledged.

LASER INDUCED NITRATIONS OF HYDROCARBONS. S. E. Godbey\* and A. E. Stanley, Research Directorate, AMSMI-RD-RE-QP, U.S. Army Missile Command, Redstone Arsenal, AL 35898-5248.

The  $\text{CO}_2$  infrared laser induced nitrations of propane, n-butane, and n-pentane using  $\text{NO}_2$  as the nitrating reagent have been achieved. A combination of techniques, including infrared spectroscopy, mass spectroscopy, and gas chromatography, was utilized to identify reaction products. The  $\text{CO}_2$  laser induced reaction of propane produced 2-nitropropane, 1-nitropropane, nitromethane, and nitroethane. The analogous butane nitration produced 2-nitrobutane, 1-nitrobutane, nitroethane, nitromethane, and 1-nitropropane. The pentane/ $\text{NO}_2$  reaction products included 2-nitropentane, 3-nitropentane, 1-nitropentane, nitroethane, and 1-nitropropane. Also identified in the reaction products in all cases were  $\text{CO}_2$ ,  $\text{NO}$ ,  $\text{CO}$ , and  $\text{H}_2\text{O}$ . The total yield of nitroalkanes was typically 15-40% depending on the alkane reacting and the reaction conditions.

\* This work was done while S. E. Godbey held a National Research Council (NRC) Research Associateship at the U.S. Army Missile Command.

FORMATION OF MALONDIALDEHYDE IN BENZOYL PEROXIDE INDUCED PLATELET AGGREGATION(\*). U. Okike, E.T. Gwebu, A. Rivers, C. Blair, R. Fagan, T. Stephenson, M. McInnis, (Department of Chemistry) M. Cole, (Department of Biological Sciences), Oakwood College, Huntsville, Alabama 35896.

Benzoyl peroxide (BPO) is used extensively in medicine in the treatment of inflammatory acne, decubitus (bedsores) and other cutaneous ulcers, and pyoderma gangrenosum. Previous studies from this laboratory have shown that BPO is a potent human platelet aggregating agent in vitro [Gwebu et al Benzoyl peroxide: A Potent Human Platelet Aggregating Agent. Central African Journal of Medicine. 29:178-180 (1983)]. We have shown that BPO-induced platelet aggregation is mediated via free radical formation (Gwebu et al: The Effect of Methional, a radical scavenger, on Benzoyl peroxide induced Aggregation. American Chemical Society, November 6, 1987). The purpose of the present study is to determine whether MDA (malondialdehyde) is formed during BPO-induced platelet aggregation. Platelet rich plasma (PRP) was prepared according to the procedure of [Gwebu et al: The Journal of the Alabama Academy of Science 59 (1) : 17 (1987)]. Platelet aggregation was induced by 0.98mM BPO. The aliquots were combined and MDA measured spectrophotometrically. Preliminary results show that MDA is not formed during BPO-induced platelet aggregation.

\*-This paper is an entrant in the Student Research Award Competition.

THE EFFECT OF PROSTAGLANDIN E, ON BENZOYL PEROXIDE INDUCED AGGREGATION. Edward Kankam, E.T. Gwebu, Ava Rivers, John Nkosi, Rose Green, Chemistry Department, Oakwood College, Huntsville, Alabama 35896.

Studies from our laboratory indicate that Benzoyl peroxide (BPO) induces human platelet aggregation in a dose-dependant manner. (Gwebu et al 1983). Platelet aggregation is regulated by prostaglandins and their derivatives by stimulating an increase in cyclic-AMP levels. Compounds that stimulate cyclic-AMP levels also inhibit aggregation. (Vance, 1988). Compounds such as vitamin E and Methional are proven to inhibit human platelet aggregation. (Gwebu et al, 1987). PGE<sub>1</sub> causes a 15-fold increase in the concentration of cyclic-AMP. The binding of Prostaglandin E to a variety of cells correlates with an activation of adenylate cyclase and the accumulation of cyclic-AMP. (Vance, 1988). The purpose of this study was to determine the effect PGE<sub>1</sub> on BPO induced aggregation and whether the effect is dose-dependant. Platelet Rich Plasma (PRP) was preincubated with PGE<sub>1</sub> (0.1 microM) for 3 minutes at 37°C followed by the addition of 10 micro liters BPO; incubation was continued for 3 min. The result indicated that PGE<sub>1</sub> inhibited BPO induced platelet aggregation.

\*This paper is entered in the Student Research Award Competition.



SYNTHESIS OF A WATER SOLUBLE POLYNUCLEOTIDE ANALOG USING ACETAMIDOACRYLIC ACID. Ronald Brown and Adriane G. Ludwick, Chemistry Department, Tuskegee University, Tuskegee, AL 36088.

The objective of this work is to explore the use of water soluble polymers as backbones for polynucleotide analogs. Polynucleotide analogs are molecules containing synthetic, non-sugar phosphate polymer backbones with pendants consisting of nucleic acid bases such as thymine and/or adenine. An attempt was made to synthesize the monomer for a polynucleotide analog using hydroxyethylthymine (HET) and acetamidoacrylic acid (AAA). A stoichiometric amount of dicyclohexylcarbodiimide and a catalytic amount of an aminopyridine were utilized to facilitate the esterification reaction at 25°C in dimethylformamide (DMF). Infrared (IR) spectra indicate that the reaction was successful. DMF-insoluble dicyclohexylurea (DCU) was characterized and an unidentified DMF-insoluble product was also present. The monomer for the analog either oligomerizes becoming the unidentified DMF-insoluble product and/or adheres strongly to DMF and is difficult to purify. In an attempt to prepare the polymer analog directly, poly(AAA) was reacted with HET under the conditions used for the AAA reaction. IR analysis indicates the polynucleotide analog was synthesized. However, it is DMF-insoluble and hence is contaminated with DCU. Work is underway to purify both the monomer for the analog and the polynucleotide analog. (Supported by NIH RR 08091)

INHIBITION OF THYMIDYLATE SYNTHASE BY PYRIDOXAL PHOSPHATE. S. C. Chen, H. H. Daron and J. L. Aull, Dept. of Chemistry, Auburn University, AL 36849.

Thymidylate synthase (TS) from Lactobacillus casei was inhibited by pyridoxal phosphate (PLP), a reagent commonly used to detect catalytically important lysine residues. The inhibition was rapid, quickly reversed when the PLP conc. was reduced by dilution, and remained reversible even after treatment with NaBH<sub>4</sub>. The reversible inhibition was competitive when dUMP was the variable substrate and noncompetitive when 5,10- methylenetetrahydrofolate was the variable substrate. The type of inhibition observed is consistent with the previously determined order of substrate addition. A tentative value of 0.6-0.7  $\mu$ M was calculated for the K<sub>i</sub> (from data with dUMP as the variable substrate) using previously determined K<sub>m</sub> values for the two substrates (J. Biol. Chem. (1978) 253, 940-945). At 0.16 mM, PLP inhibited to a greater degree (60% inhibition) than the following analogs: pyridoxal (10%), pyridoxine (15%), pyridoxamine (30%), pyridoxamine phosphate (36%), and benzaldehyde (7%). The reaction of TS with PLP resulted in the appearance of a new absorbance peak at 330 nm. These results indicate that PLP inhibits TS by acting as a substrate analog and competing with dUMP at the active site rather than by forming a Schiff base with a catalytically important lysine residue.

COBALT(II) AND COBALT(III) COORDINATION COMPOUNDS: A LABORATORY EXPERIMENT. W. Katrina Pringle and Nick Thomas, Chemistry Department, Auburn University at Montgomery, Montgomery, AL 36193.

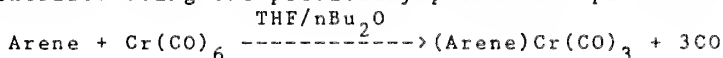
A laboratory experiment has been developed for use in senior inorganic laboratory courses. Coordination of 1,10-phenanthroline (phen) to cobalt(II), followed by oxidation of both metal and ligand yields  $\text{Co(quin)}_3^{+}$  (quin = 1,10-phenanthroline-5,6-quinone). Treatment of the latter with EDTA liberates the free quin. As a laboratory teaching exercise, this experiment introduces students to a variety of important reactions including complex formation, and oxidation and ligand displacement reactions. In addition, the intermediate complexes are isolated and characterized, providing students with a practical opportunity to apply spectroscopic techniques to study the properties of coordination compounds.

THE SYNTHESIS AND CHARACTERIZATION OF POLYNUCLEOTIDE ANALOGS USING PARTIALLY HYDROLYZED POLYETHYLOXAZOLINE. Ralinda L. Jones, Kevin Carter and Adriane G. Ludwick, Chemistry Department, Tuskegee University, Tuskegee, AL 36088.

A polynucleotide analog is a synthetic macromolecule analogous to the naturally occurring polynucleotides (DNA and/or RNA). Biological testing has been done on an analog synthesized in this laboratory (McCloud, 1984) consisting of 70% hydrolyzed polyethyloxazoline (PEOX) with thymine pendants grafted to the backbone. The analog proved to be too toxic for the host cells. However, the backbone (70% hydrolyzed PEOX) demonstrated antiviral activity against herpes simplex I and II and a measles virus. More recently, Dow has commercialized PEOX (1986). In this work, the commercial PEOX-200 (average molecular weight of 200,000) has been 50% hydrolyzed and grafting of uracil-containing pendants to the partially hydrolyzed PEOX has been attempted. These products are being characterized and will be biologically tested. Viscosity measurements of the partially hydrolyzed PEOX indicate the polyelectrolyte behavior of the copolymer.  $^1\text{H}$  and  $^{13}\text{C}$  Nuclear magnetic resonance spectra give structural evidence for both the backbone and the crude analog preparation. Thin layer chromatographic evidence supports the conclusion that the analog has been synthesized. Further research will include purification attempts of the crude analog, synthesis and characterization of a 5-fluorouracil-containing analog, and utilization of PEOX backbones hydrolyzed to different extents. (Supported by NIH RR 08091)

THE PREPARATION AND SPECTRAL PROPERTIES OF ARENETRICARBONYLCHROMIUM COMPLEXES. Christopher A.L. Mahaffy and John B. Hamilton, Department of Chemistry, Auburn University at Montgomery, Montgomery, AL 36193-0401.

A large number of arenetricarbonylchromium complexes containing amino and alkoxy groups have been synthesized using the previously published<sup>1</sup> procedure.



and their 400 MHz <sup>1</sup>H/<sup>13</sup>C NMR spectra have been determined. Possible restricted rotation in these complexes has been investigated using SCS values and variable temperature NMR studies.

The signal for the dimethylamino group in N,N,2,4,6-pentamethylanilinetricarbonylchromium shows a doubling just below room temperature indicating restricted rotation about the ring-N bond. The Cr(CO)<sub>3</sub> group introduces a facial asymmetry into the complex and can thus be used as a probe to investigate restricted rotation in aromatic molecules.

1. C.A.L. Mahaffy and P.L. Pauson, Inorg. Syn., **19**, 154 (1978).

#### LEAD DETERMINATION BY FAST SWEET STRIPPING ANALYSIS.

Raymond E. Isbell, Ph.D., and Wayne Nixon Spillers, Department of Chemistry, University of North Alabama, Florence, AL 35632.

Problems with the amount of lead in various sources of drinking water prompted this investigation. Detection limits using atomic absorption were established and found to be too insensitive for very small amounts of lead in water. Stripping analysis using a Sargent-Welch model 3001 Polarograph was found to be much more sensitive. This study deals with the establishment of the limits of sensitivity of this Polarograph for lead analysis.

#### THE EFFECTS OF SMALL IONS UPON CATIONIC MICELLAR SYSTEMS.

Barry Corona, Dept. of Chemistry, Spring Hill College, Mobile, AL 36608. Robert Nauman, Dept. of Chemistry, Louisiana State University, Baton Rouge, LA. 70803

The effect of a number of additives on micellar systems of tetradcyltrimethylammonium bromide were investigated. The concentration of solubilized benzene in each system was determined by using spectrographic techniques. The results were then analyzed.

## GEOLOGY

TAPHONOMY OF COMMON BENTHIC FORAMINIFERA FROM SAN SALVADOR, THE BAHAMAS. Mark W. Peebles, Dept. of Geology, Auburn Univ., Auburn, AL 36849.

Taphonomy is the study of the processes of preservation and how they affect information in the fossil record. Four different processes were investigated as to how they affect the preservation of several common shallow-water benthic foraminifera from San Salvador. While there is selective predation of foraminifera, this predation is not species selective. Many different species show signs of predation, as evidenced by large borings perpendicular to test surfaces and with beveled edges. However, the most common species are more heavily preyed upon in any given area. A foraminiferan, Rosalina sp. was found to use the tests of larger foraminifera as a substrate. Care should be taken when classifying predation based on borings, as the borings left by this species resemble borings left by predators. Microborings are found in virtually any exposed carbonate substrate in the tropical waters of the Bahamas. Though most studies of microborings find no differences between substrates, this study demonstrates that there are differences among host taxa with respect to extent of infestation and location of infestation within the test. The primary differences are at the suborder level; members of the Suborder Rotaliina are not as bored as specimens of the Miliolina taken from the same sample. Abrasion and dissolution leave recognizable signatures on the test surface of foraminifera. Abrasion breaks off large areas of the test, but it more often polishes the test surface without causing extensive damage to the test. The effects of dissolution are harder to see at low magnifications, but with only small amounts of dissolution the integrity of the test is damaged. Dissolution, including that caused by microboring organisms, is the primary process affecting preservation in this environment.

SIR CHARLES LYELL, ENGLISH GEOLOGIST, RESEARCHES ALABAMA FOSSILS IN 1846. Norman B. Cranford, Department of Geology, Auburn University, AL 36849-5305.

Alabama geologists can be proud that their state has attracted many famous scientists to study the state's geology. It was Alabama that attracted one of the most renowned geological scientists of the nineteenth century. That gentleman, Charles Lyell, was a founder of modern historical geology. It was during Lyell's 1845-1846 visit to the United States that he described some of Alabama's most significant geological formations. He described the Claiborne group, exposed in the bluff at Claiborne on the Alabama River in Monroe County, the St. Stephens Bluff, and the Jackson formation. Lyell also listed their fossil assemblages such as 'the primitive whale-like mammal "Zeuglodon", or Basilosaurus cetoides, the large foraminifer Lepidocyclina, and fossil shells such as Ostrea sellaeformis (Conrad). I wish to acknowledge Lewis S. Dean of the Geological Survey of Alabama who alerted me to a useful reference.

AN OVERVIEW OF OXYGEN-RELATED BIOFACIES IN FINE-GRAINED MARINE STRATA.  
Charles E. Savrda, Dept. of Geology, Auburn Univ., Auburn, AL 36849

Reconstruction of the oxygenation history of marine basins during the deposition of ancient fine-grained strata is of considerable importance. Bottom-water oxygen levels control the distribution of organic-rich, hydrocarbon source strata, and reflect paleoceanographic changes modulated by temporal variations in sea level, basin configuration, and climate. Recent studies of contemporary environments and ancient strata have led to the refinement of biofacies models that employ both body fossils and trace fossils in the evaluation of paleo-oxygenation. Five oxygen-related biofacies are currently recognized. Described in order of decreasing oxygenation, these are the 1) aerobic, 2) dysaerobic, 3) exaerobic, 4) anaerobic, and 5) anoxic biofacies. Aerobic biofacies are characterized by bioturbate sediments and diverse assemblages of large, heavily calcified body fossils. Dysaerobic biofacies are reflected by bioturbate sediments and, depending on taphonomic factors, lower diversity assemblages of typically smaller, less heavily calcified body fossils or the absence of body fossils altogether. Exaerobic biofacies are characterized by laminated sediments with epibenthic body fossils as the sole in situ macroinvertebrate component. Anaerobic biofacies are characterized by laminated strata, with possible microbioturbation, containing in situ benthic microfossils and the remains of epiplanktonic or nektonic organisms. Anoxic biofacies are reflected by laminated strata containing similar allochthonous faunal elements but lacking microbioturbation and in situ benthic microfossils. When synthesized and incorporated into a trace-fossil tiering model, trends of decreasing diversity, burrow diameter, and depth of penetration of biogenic structures with decreasing oxygenation provide an additional means of evaluating redox histories for "dysaerobic" strata.

GEOLOGY OF THE EAGLE CREEK GOLD DISTRICT. Mark J. Johnson and Robert B. Cook, Jr., Department of Geology, Auburn University, AL 36849-5305.

The Eagle Creek gold district is located in east-central Alabama and consists of several prospects which occur within the Katy Creek fault zone. The Katy Creek fault marks the southeastern boundary of a major regional structural feature, the Brevard zone. Lithologies within the Brevard zone consist of a sequence of locally graphitic metasediments, the Jackson's Gap Group. Rocks within the Jackson's Gap Group have been subjected to five deformational periods and two metamorphic events, one prograde and one retrograde. Geochemical data indicate the gold mineralization is confined to shear controlled, layer-parallel sites within carbonate-bearing, siliceous, red/orange and gray/green phyllonites, and locally, quartz-sericite schist. Quartz-sericite schist, itself an alteration product of porphyroclastic mylonite gneiss, contains anomalous gold only where it is associated with the altered phyllonite. The gold mineralization is thought to represent remobilization of gold from within the Jackson's Gap Group by hydrothermal processes. These fluids were channeled along the Katy Creek fault during the retrogressive metamorphic event.

## GEOLOGICAL INFORMATION IN EARLY ALABAMA NEWSPAPERS: 1831-1855:

Lewis S. Dean, Geological Survey of Alabama, P.O. Box 0, Tuscaloosa, AL 35486.

Early Alabama newspapers contain significant geological information generally not recorded in formal geologic literature. Examples include the discovery and first gold mining activity in Alabama during 1831; the letters of Professor R.T. Brumby of the University of Alabama on the importance of a geological survey of Alabama; and the field notes and letters of the first State Geologist Michael Tuomey. The Mobile Register of May 9, 1831 contains a notice on "Alabama Gold" wherein the discovery and first episode of Alabama's "gold rush" is described. Gold was first found in old Autauga County (Chilton Co.) along a tributary to Chestnut Creek with a reported production of \$1,000 in 1831. In 1844 the Tuscaloosa Journal published six letters from Professor Brumby to elicit interest in a geological survey of Alabama. The University of Alabama responded in 1847 with the appointment of Michael Tuomey to begin the first systematic geological survey of the State. The results of Professor Tuomey's initial survey on the geology and mineral resources of the Valley and Ridge and Plateau regions of Alabama were published in the Tuscaloosa Monitor. These reports generated such interest in his work as to lead to the passage by the Alabama Legislature in 1848 of a resolution appointing Tuomey State Geologist and thereby beginning the work of the Geological Survey of Alabama. In 1855 the Montgomery Advertiser and Daily Mail published letters by Tuomey describing the geology and mining of copper, gold, and soapstone found in the Alabama Piedmont.

A RICH VERTEBRATE FOSSIL ASSEMBLAGE FROM THE UPPER DEMOPOLIS FORMATION OF ALABAMA AND MISSISSIPPI. Kraig Derstler, Dept. of Geology and Geophysics, Univ. of New Orleans, New Orleans, LA 70148.

Numerous reptile fossils occur in the upper Demopolis Formation (Upper Cretaceous, Campanian/Maastrichtian boundary) of western Alabama and northeastern Mississippi. The fauna is present within a thin interval extending a few meters on either side of the contact between the Bluffport Marl Member of the Demopolis Formation and the underlying unnamed member. It is dominated by the mosasaurs Plioplatecarpus sp. and Mosasaurus conodon, and the sea turtles Prionochelys nauta, Toxochelys barberi and T. moorevillensis. Other reptiles include the mosasaur Prognathodon cf. P. solvayi, the turtles Protostega sp., ?Peritresius, ?Bothremys, and a chelosphargine, as well as a plesiosaur, crocodile and an ?ornithischian dinosaur. Fish are relatively uncommon. Among the identified forms are Enchodus, Pachyrhizodus, a large species of Squalicorax, Pseudocorax, Ischyryza and a Myliobatis type of ray. The fauna matches that from the age-equivalent Marlbrook Formation of Arkansas. The mosasaurs are similar, if not identical to those found in the upper Pierre Formation of South Dakota and the Craie Brun Phosphate of Cibley in Belgium.

SCANNING ELECTRON MICROSCOPY OF THE CRETACEOUS SELMA CHALK IN DALLAS COUNTY, ALABAMA. David T. King, Jr., Ira Holston, and Amanda Espy, Department of Geology, Auburn University, AL 36849-5305.

Petrographic analysis and stratigraphic correlation of surface exposures and samples from shallow subsurface wells in Dallas County, Alabama, shows that the Mooreville Chalk and Demopolis Chalk, two formations in the Upper Cretaceous Selma Group, are comprised of several sedimentary facies. These facies are sand, silty marl, marl, and chalky marl. No pure chalk exists in the study area. Previous studies have documented the sea-level history of Selma deposition: three cycles of sea-level rise and fall are represented with notable high stands associated with two of the episodes of sea-level rise. In Dallas County, these high stands are represented by chalky marls. SEM imaging of samples from all facies of the Selma shows that progressive carbonate diagenesis has affected the sedimentary fabrics. Diagenetic grades are described by a numerical scale, 1 to 5. The most strongly affected rocks (grades 3, 4, and 5) are found in two situations: 1) the chalky marls correlative with high sea-level stands and 2) the interior surface of joints. The chalky marl diagenesis can be attributed to higher percents of calcareous biogenic constituents relative to clay content and higher initial porosities. The joint-related diagenesis is a late post-depositional effect. Solution transfer at different times accounts for the diagenesis in the two situations described above. The grades of diagenesis (1 - 5) relate the condition of biogenic constituents regarding overgrowths and corrosion, the extent to which carbonate overgrowths interlock, the loss of visual porosity, and the relative size of the aggraded crystals.

PETROGRAPHY OF MIGMATITES IN THE AUBURN FORMATION, LEE COUNTY, ALABAMA. Mark R. Colberg, Department of Geology, Auburn University, AL 36849-5305

Unusual migmatitic muscovite-biotite schists, closely associated with numerous sill-like intrusions of the Farmville granite, occur in a zone of sheared rocks within the Auburn formation of the Alabama piedmont. A massive medium grained biotite paragneiss has been identified as the paleosome. The migmatite is a very coarse grained muscovite biotite schist containing augen-like lenses, pods, and stromatic layers of tonalitic leucosome. The melanosome consists of muscovite, biotite, garnet, and tourmaline. Pods of relict biotite gneiss paleosome impart a button texture to the schistose melanosome. Mineral assemblages in the migmatite, and associated pelitic schists and calc-silicate bodies suggest metamorphic conditions below minimum melting temperatures. Textural evidence and mineralogical variations suggest migmatization by combined metasomatism and metamorphic differentiation. Muscovite greatly increases in abundance during the process, and clearly grew by replacement of plagioclase. Quartz also decreases in abundance in the melanosome as migmatization proceeds. The melanosome plagioclase and quartz are thought to have migrated to low pressure zones where the minerals were redeposited to form the leucosomes.

SEDIMENTOLOGICAL RELATIONSHIPS WITHIN CREVASSE SPLAYS ASSOCIATED WITH THE TENSAW RIVER, MOBILE-TENSAW RIVER DELTA, ALABAMA. David S. Felton and Robert A. Gastaldo, Auburn University, AL 36849-5305

The Mobile-Tensaw river delta is a prograding alluvial plain developed within the past 9000 years. Sedimentation within the lower delta plain estuarine bays is controlled by fluvial processes, with minor tidal influence. Two crevasse splays associated with Chacaloochee Bay are being examined in an effort to develop a model for bayfill sequences. Vibracores and box cores were extracted along transects through a 1 km area within a recently developed splay. An older splay (Conway Creek) will be cored to provide comparative data. Laboratory analyses consist of 1) Identification of sedimentary structures, 2) Grain size and mineralogical composition, 3) Assessment of plant and animal macrodetritus, and 4) Carbon content. Preliminary results indicate that a 2 m sequence of crevasse sediments overlies prodeltaic muddy sands. In crevasse channels, silty muds, topped by detrital organics, are overlain by fine sands. Subaerial sites yield silty muds topped by an organic-rich peat zone containing leaf and wood fragments transported from distal upper delta plain sites. Sedimentary structures include unidirectional cross-stratification in channel sands and thin laminae within the silty muds. All sediments are bioturbated to some degree. The predominant macrofaunal body fossils are Rangia shells.

LINEAMENT ANALYSIS OF THE SELMA CHALK IN MONTGOMERY COUNTY, ALABAMA. Enid Bittner and Alan Sanders, Department of Geology, Auburn University, AL 36849-5305.

Lineament analysis of the Selma chalks and marls of Montgomery County was done primarily by remote sensing techniques and field mapping. The remote sensing included aerial photographic lineament analysis and 7.5' topographic map straight stream-segment analysis. In both techniques the lineaments were traced, digitized and a computer map generated. The digitized data was also used to construct frequency diagrams to determine correlation between the two methods and to construct lineament density maps. Results from both techniques of analysis show major lineament trends to the northeast and northwest. These results are similar to the field mapped fractures and therefore, support the techniques as viable methods for mapping lineaments in the chalk terrane. The lineament density map shows a strong east-west girdle of high lineament density in the central part of the county. The preferred concentration supports a previously recognized stratigraphic control of fracturing. In summary, results from the various techniques used to determine lineament concentration and orientations support each other and the field data. The close correlations promote the use of remote sensing in the mapping of lineaments and fractures in the Selma chalk.



GEOCHEMISTRY AND THE PETROGENESIS OF ANORTHOSITE IN THE STILLWATER COMPLEX, MONTANA. Peter A. Salpas, Dept. of Geology, Auburn University, AL 36849-5305.

The Stillwater complex is a mafic layered intrusion that contains a minimum of seven anorthosite layers. In the stratigraphically lower portion of the intrusion, these are thin (up to 3 meters), but in the central portion there occur two thick units - AN-I (350 meters) and AN-II (570 meters). Texturally, these latter rocks are composed of cumulus plagioclase with varying (0-20%) amounts of intercumulus pyroxene. Geochemical studies indicate that there exist no trends of trace element compositions with stratigraphy such as would be expected for rocks that crystallized from an anorthositic magma. Rather, trace element concentrations vary inversely with pyroxene mode, a manner that is inconsistent with the pyroxenes having crystallized from trapped liquid, as suggested by the rocks' textures. A study of a 10 m X 10 m outcrop in AN-II indicates that rocks of different pyroxene mode occur as discrete meter-size units within the larger anorthosite layers. A model has been developed which explains these observations. It says that the anorthosites were emplaced as plagioclase crystal/liquid mushes which solidified by growth of adcumulus plagioclase and pyroxene from the main magma body, and orthocumulus additions to these minerals as portions of the mush became closed to diffusion.

#### FORESTRY, GEOGRAPHY, CONSERVATION AND PLANNING

Digital Terrain Modeling: Techniques in Basin Analysis. Paul F. Deaver, Dept. of Geography, University of Alabama, Tuscaloosa, AL 35487-1982. Paul F. Deaver and Dr. John M. Harlin.

Digital Terrain Modeling (DTM) is a powerful tool for use in basin analysis. This study examines the methodology of DTM as it might be employed in erosion-sedimentation research. Each step of the modeling and verification process is carefully analyzed. Included in the analysis are the development of hypsometric curves, creation and analysis of grid files, filtering and filter verification techniques, contouring, and the calculation of volumes.

## Abstracts

FORESTRY IN SCOTLAND. Wilbur B. De Vall, President, Proxy Services, Ltd., Auburn, AL. 36830

Forests of the Highlands and Lowlands of Scotland declined over long centuries as a result of clearing for agriculture, wild fire, need for firewood, and harvesting for lumber and other construction products. The kings of Scotland passed laws for the protection of growing timber. Soon after 1230 the French monks began to grow seedlings for planting on their estates. Later the Dukes of Atholl set a striking example when they planted 14 million larch trees on 10,000 acres between 1764 and 1826. Reforestation became an established practice after beech was brought from England, sycamore from France, spruce from Norway, and larch from the Tyrolese region of the Alps. Exploring botanists introduced Douglas-fir, Western hemlock, Sitka spruce, and Lodgepole pine from British Columbia. The practice of forestry was formalized when the Forestry Commission was set up by the Forestry Act of 1919. It operates under the direction of the Secretary of State for Scotland. Forests are currently managed on 10% of the total land area, comprising about 2 million acres. Half of this is under private ownership and half under State control. The Scottish Woodland Owner's Association, formed in 1959, comprises 1200 members. Its goals are to negotiate forest policies, grants-in-aid for forestry operations, monitor taxation, plan land use, and foster a timber marketing policy. Members who own less than 100 acres each represent 50% of its membership. Planting, which has State priority, amounts to approximately 8,000 acres per year. Plantings average 60% Sitka spruce, 30% Lodgepole pine, and 10% hardwoods of various species, principally oaks. The annual harvest goes 50% to sawmills, 21% to one pulpmill, 6% to particle board plants, and 2% for mine timbers.

### Northeast Alabama's Persistent Cultural Shatterzone

This paper presents preliminary analysis of the existence and persistence of a cultural boundary zone which extends through a four-county area in Northeast Alabama. Archaeological data suggests this zone's existence as early as 10,000 B.C.

Beginning with the Late Paleo/Early Archaic period archaeological data suggests an ever shifting cultural border across the present day counties of Calhoun, Cherokee, Etowah, and Talladega Counties which marks the southern boundary of diagnostic cultural traits associated with cultures along the Tennessee River and Northwest Georgia which at the same time marks the northern boundary of diagnostic cultural traits usually associated with prehistoric developments occurring along the Gulf coast and areas to the west.

Maps of folk culture traits produced over the past several decades continue to place boundaries in this same area of Alabama.

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Jacksonville State University

SOLID WASTE MANAGEMENT - OPTIONS FOR ALABAMA IN THE COMING DECADE. Michael W. Mullen, Center for Environmental Research and Service, Troy State University, Troy, Alabama 36082

Solid waste management is and will continue to be a major challenge for local government in Alabama. The disposal capacity crisis which already exists will get worse before substantial new disposal capacity can be added. New technical requirements will make landfill construction and operation more expensive. A "hard-path" approach consisting only of technological "fixes" will not result in an optimal solution. An optimal solution can be achieved only by a "soft-path" approach. Social actions such as waste minimization and recycling are essential components of any lasting solution to solid waste management problems. Such social actions along with appropriate, site-specific application of disposal technologies can produce a successful "soft-path" solution to the solid waste crisis. Separation of solid waste into recycleable fractions at the source can truly create opportunity out of crisis. Recycling diverts waste away from disposal facilities reducing the need for new disposal capacity. Secondary benefits include conservation of natural resources and reduced pollution. Successful transition from disposal oriented waste management to more resource conservation oriented practices depends upon the level of knowledge of local officials and their leadership. Local government leaders need an accurate source of information on the benefits of recycling and on how to initiate recycling projects. State government could play a critical role by developing mechanisms to speed development of state markets for recycled materials. Local government could develop and implement a coordinated marketing plan for recycleables with assistance from the ADECA and their municipal and county associations.

THE AMIGA COMPUTER AS A CARTOGRAPHIC TOOL. Cyrus B. Dawsey, Department of Geography, Auburn University, Auburn, AL 36849

Computer cartography has traditionally been tied to systems which are very expensive and difficult to learn. The recently released line of Amiga personal computers provides a relatively cheap and easy to use tool for storing, manipulating and displaying graphic data. The author has written several programs with which a user of low computer literacy can create personalized choropleth maps of any area of interest. Base maps are digitized directly from an acetate sheet taped to the monitor, data are input by responding to menu prompts, and final maps can then be produced where distribution patterns in up to 14 color hues are shown. Everything is done in the friendly environment of mouse and icons, on a computer which can be purchased for under \$800.00

1987, INTERNATIONAL YEAR OF SHELTER FOR THE HOMELESS (IYSH): A REVIEW. Surendra P. Mathur, Dept. of History & Political Science, Ala. A & M Univ., Normal, AL 35762.

Appalling housing shortage and hectic population growth force millions to live either in slums and squatters or without provision of shelter conditions. The world is experiencing dramatic population change from 4.4 billion (1980) to 6.4 billion by year 2000. At present one billion people are living in the Third World cities alone. By year 2000 these cities will be overcrowded with another one billion people. Considering the magnitude of the problem the United Nations General Assembly, at its forty-first session, proclaimed 1987 as the International Year of Shelter for the Homeless (IYSH). Although the UN Habitat Conference (1976) was aimed to highlight global awareness of the shelter crisis, the governments did not fully realize the magnitude of the problem. IYSH is a renewed commitment of the UN agencies to urge various governments to show political commitment to the shelter needs of the poor, to prepare or review shelter strategies and to implement shelter programs. The year 1987 was marked with several international conferences to enhance global awareness and cooperation. About 200 professionals and experts from 48 countries participated in the International Conference on Shelter in Developing Countries in London, September 1987. The Conference was cosponsored by ICTR UNESCO and IYSH. This presentation also focuses several activities undertaken worldwide to meet this challenge.

DETECTION OF THE SOUTHERN PINE BEETLE USING COLOR INFRARED PHOTOGRAPHY. William R. Strong, Dept. of Geography, Univ. of North Alabama, Florence, AL 35632.

The forests of northwest Alabama have been under increasing attack by the southern pine beetle. The results are a loss of valuable timber and potential income for the grower. Present methods of detecting the infested areas are laborious and time consuming. These methods involve detection and mapping of forested areas by Alabama Forestry Commission personnel viewing the areas from aircraft. Recent innovations in remote sensing offer the means to detect infestations using aerial color infrared (CIR) photography and multispectral scanning. This study was conducted in order to determine the feasibility of using hand-held 35 mm CIR photography for detection and mapping of the location of pine beetle infestations. Photographic results were positive and correlated with field checks. Turn around time for processing was quick and all infestations were mapped for eventual control.

THE CARTOGRAPHIC AND PICTORIAL ART OF SAMUEL H. LOCKETT, AN ALABAMA ARTIST IN AFRICA. David Icenogle, Department of Geography, Auburn University, Auburn, AL 36849.

Between 1870 and 1878 approximately fifty ex-Union and ex-Confederate officers served as advisors to the Egyptian army of the Khedive Ismail, under the direction of General Charles P. Stone, a disgraced and discredited ex-Union officer. Stone, a capable administrator, served as Chief-of-Staff of the Egyptian army for a total of thirteen years. One of Stone's more capable assistants in Egypt was an Alabamian, Samuel H. Lockett (1837-1891). Lockett, a former Colonel in the Confederate army, spent two years in Egypt and Ethiopia as a cartographer and landscape artist. His masterpiece was the Carte General d'Afrique (1877), which is a great monument of Victorian cartographic art. While on a mission to Ethiopia in 1876, Lockett painted a total of twenty landscape watercolors. Twelve of these paintings are located in the Alabama Department of Archives and History. Slides of these paintings are publicly shown for the first time in this paper.

POLAND: GEOGRAPHIC REALITY VS. TEXTBOOK INTERPRETATION. D. Gregory Jeane, Department of Geography, Auburn Univ., AL 36849.

Poland, unique among the East European nations, is the only Warsaw Pact State in which the majority of the agricultural production is accomplished on private farms and in which the church is both vibrant and actively involved in social and economic matters. These two factors, combined with a 1000 year history, partly account for a fascinating, but haunting cultural landscape. World regional text coverage of Eastern Europe is usually limited and highly generalized. A recent field opportunity in Poland provided an opportunity to observe and experience social and economic conditions while making an extensive circuit encompassing roughly 60% of the nation's territory. The result was the realization of a considerable gap between generalized text information and the reality of everyday conditions under a totalitarian regime. Recent political and economic setbacks have contributed to the deterioration of Poland's standard of living, resulting in an increasing reliance upon a vigorous black market for anything above minimum basic needs, a market that operates on a price differential 4 times greater than the official exchange (an official rate of 160 zlotys/\$1 US translates to 670 zlotys/\$1 US on the black market). The inability of the government to meet the basic needs of its citizens can be inferred from private construction of greenhouses for vegetable production and of single-family dwellings; officially, construction materials for private use are unavailable because of state priority. These are but two examples of socialism gone awry.

## PHYSICS AND MATHEMATICS

ON COORDINATING THE LOWER LEVEL MULTIPLE SECTION MATHEMATICS COURSES. T.Daneen Belcher, S. Chandra Misra, William L. Lester, Herman L. Windham. Department of Computer Science and Mathematics, Tuskegee University, Tuskegee, AL 36088.

The lower level courses taught in freshman and sophomore years in a college often have more than one section. The pace of the course, the material covered in different sections, the variability in grading from instructor to instructor, the level of difficulty of examinations, and the student's level of preparedness all can become a real problem if they are not handled properly. One effective way to overcome such problems is to coordinate the lower level multiple sections courses. The faculty members of the Mathematics Department at Tuskegee University have used this approach for the last fifteen years. Under such a scheme, a coordinator is appointed by the Head of the department. The responsibilities of the coordinator include writing overall objectives of the course, determining course material to be covered in a semester, keeping pace of the course, etc. An average of five common tests, excluding the final examination, are given in the evenings. Coordination has eliminated substantially all the problems encountered in uncoordinated courses mentioned earlier. It also prepares students better to take higher level mathematics courses. When first implemented in 1973-74, coordination was quite unpopular among students and the rate of satisfactory grades (C or above) was quite low as compared to previous years. The rate of satisfactory grades remained stable after a few years, however this rate is still lower than expected. Probable reasons for this phenomenon have been addressed in this paper.

## SOLIDIFICATION RANGE OF NI-BASED SUPERALLOY MAR-M246 (Hf) \*

M. D. Aggarwal, R. B. Lal and S. A. Oyekenu, Department of Physics, Alabama A & M University, Huntsville, AL 35762

The Ni-based superalloys are complex materials having high creep rupture strength, excellent oxidation resistance and capable of maintaining their room temperature physical and mechanical properties at elevated temperatures. The superalloy MAR-M246(Hf) consists of 12 elements viz., Ni, Cr, Co, Mo, W, Ta, Al, Ti, C, B, Zr and Hf. The various elements go into the solid solution to provide one or more properties like oxidation resistance, mechanical strength etc. The width of the solidification range is an important parameter in the manufacture of these materials specially for the process of directional solidification. The aim of this work is to predict solidus-liquidus data of MAR-M246(Hf) which is used in the manufacture of space shuttle main engine. This is then compared with the experimental solidification range measured using Perkin Elmer Differential Thermal Analyser DTA 1700.

\*Work supported by NASA Grant NAG8-076

ANALYSIS AND INTERPRETATION OF SATELLITE FRAGMENTATION DATA. G. D. Badhwar, NASA Johnson Space Center, Houston, TX 77058 and A. Tan, Department of Physics, Alabama A&M University, Normal, AL 35762.

The velocity perturbations of the fragments of a satellite can shed valuable information regarding the nature and intensity of the fragmentation. A feasibility study on calculating the velocity perturbations from existing equations was carried out by analyzing 25 major documented fragmentation events. It was found that the calculated values of the radial components of the velocity change were unusually high when the fragmentation took place near the apogee or perigee and for near circular orbits having eccentricities of 0.002 or less. The calculated values of the velocity perturbations in the two other orthogonal directions were, on the other hand, mostly realistic. The calculated variances in the velocity perturbations indicate that they have the smallest values for collision induced breakups and the largest values for low intensity explosion induced breakups. The corresponding variances for high intensity explosion induced breakups generally have values intermediate between those of the two other categories. A three dimensional plot of the variances in the two orthogonal velocity perturbations and the plane change angle shows a clear separation between the three major types of satellite breakups. This information is used to reclassify a number of satellite fragmentation events of unknown causes. Cosmos 1375 and Cosmos 839 are thus reclassified as collision induced breakups; Cosmos 1275 and Cosmos 61-63 are reclassified into the high intensity explosion category while Nimbus 4 and Transit 4A are reclassified into the low intensity explosion category.

FACTOR ANALYSIS AS A FORECASTING TOOL. Oskar M. Essenwanger, Army Missile Command, RD&E Center, Redstone Arsenal, AL 35898.

Many authors consider factor analysis predominantly as a diagnostic tool. These authors rely mostly on regression analysis if a multitude of predictors are available.

The calculation of factors is related to the derivation of empirical polynomials which have been used as prediction tools. Thus factor analysis is suitable as a prediction technique, but many authors may still prefer regression analysis because it is a very simple method.

It will be illustrated that factor analysis has unique features as a prediction tool which may favor its use where regression analysis does poorly. First, only the factors must be known at prediction time. Thus predictors can be included which occur later than the time of prediction. Secondly, regression techniques fail in the prediction of extremes because this method relies heavily on persistence. If the extremes comprise a considerable fraction of the predictand such as in some atmospheric elements, a prediction tool based on factor analysis may be better suited.

THERMAL RESPONSE OF ROADWAY MATERIALS TO METEOROLOGICAL CONDITIONS.  
Randy D. Russell, Department of Physical Sciences,  
 Auburn University at Montgomery, Montgomery, AL 36193

Accurate measurements of roadway surface temperatures are necessary for the prediction of roadway hazards due to icing. The diurnal cycle of heating and cooling at the roadway surface produces a temperature wave that propagates downward into the roadway and underlying subgrade soil. Thermocouples embedded in the roadway record temperature fluctuations which are somewhat smaller in amplitude and shifted in phase relative to the temperature fluctuations at the surface. Assuming sinusoidal temperature fluctuations at the surface and homogeneous composition, an analytical solution to the heat equation may be found which relates the subsurface fluctuations to those at the surface. In the present paper, the analytical solution is compared to numerical solutions of the heat equation for more realistic fluctuations in surface temperature and variable subsurface composition. The model energy budget at the roadway surface includes the solar and terrestrial fluxes of radiation, sensible heat transport, and thermal diffusion.

This work was supported by the Research Grant-In-Aid Program of Auburn University at Montgomery.

MAGNETIC RESONANCE STUDY OF THE COBALT ION IN LANTHANUM ZINC DOUBLE NITRATE. Henry W. Glotfelty, Dept. of Physics, Samford University, Birmingham, AL 35229. J. W. Culvahouse, Dept. of Physics, University of Kansas, Lawrence, KS.

The spin Hamiltonian parameters of the  $\text{Co}^{2+}$  ion in the X site of the Lanthanum Zinc Double Nitrate ( $\text{LaZnDN}$ ) crystal have been determined from an Electron-Nuclear Double Resonance (ENDOR) investigation. The X site is a distorted, hydrated complex of the form  $\text{Zn}(\text{6H}_2\text{O})^{2+}$ . The magnetic hyperfine parameters A and B were found to be 295.01(3) MHz and 283.01(8) MHz, a refinement over known values obtained from an early electron paramagnetic resonance (EPR) study. The pseudo-nuclear Zeeman parameters  $\sigma_{\parallel}$  and  $\sigma_{\perp}$  were found to be .44(2) and .45(4), respectively. The electric quadrupole constant P was found to be -.03(1) MHz. Since the trigonal distortion of the X site of  $\text{LaZnDN}$  is small, the spin Hamiltonian parameters of the cobalt ion are nearly isotropic as compare to the spin Hamiltonian parameters found for the cobalt ion in the more distorted X site of  $\text{LaMgDN}$ . The small electric quadrupole interaction is another indicator of the nearly cubic symmetry of the X site. All ENDOR measurements were made at 4.2K. No ENDOR signals were seen from the cobalt ion in the Y site of the  $\text{LaZnDN}$  crystal although the EPR signals were clearly seen. The research was supported by a grant from the National Science Foundation.



ROLE OF MUFFIN TIN ORBITALS IN LINEAR ENERGY BAND THEORY. P. C. Sharma, Physics Department, Tuskegee University, Tuskegee, AL 36088.

An approximate linear method for solving the band-structure problem in the angular momentum representation is presented. Canonical band theory is developed and it has been shown that the important ingredients of this gourmet method to calculate the cordobleau band structures are volume-and energy-independent structure constants and parameters. These quantities completely specify the energy-band structure of a material in a given structure. The canonical bands are presented for bcc structures at points of high symmetry.

The financial support provided by the grant NSWC contract N60921-86-C-A226, subcontract No. 86-206 is thankfully acknowledged.

ELECTRON ENERGY BANDS IN A ONE-DIMENSIONAL PERIODIC POTENTIAL, Shiva S. Subramanyam, Abraham George, Department of Electrical Engineering and P. C. Sharma, Department of Physics, Tuskegee University, Tuskegee, AL 36088.

Equations for energy eigen value, fermi energy, fermi vector, total ground state energy and density-of-states have been derived under empty lattice approximation for 1-d and 3-d cases. These equations have been used to calculate the value of above quantities for some simple metals and doped n-and p-type materials. The calculated values agree very well with the experimental values.

The financial support provided by the grant NSWC contract N60921-86-C-A226, subcontract No. 86-206 is thankfully acknowledged.

PHONON INTERACTIONS AND THEIR ROLE IN PHONON-CONDUCTIVITY OF SOLIDS: APPLICATION TO CARBON TETRABROMIDE, P. C. Sharma, H. N. Narang and I. K. Kothari, Tuskegee University, Tuskegee, AL 36088.

Using Callaway integral equation for lattice thermal conductivity, an equation has been obtained. This phenomenological expression relates the average Gruneisen parameters and phonon velocities to the pressure dependence of thermal conductivity. We apply this technique for the first time and the pressure dependence of Gruneisen gammas have been predicted.

One of us ( P. C. S ) thankfully acknowledge the financial support provided by the grant NSWC contract N60921-86-C-A226, subcontract No. 86-206.

## Abstracts

LABORATORY INSTRUCTION DOES NOT AID THE STUDENT IN LECTURE.  
A STUDY INVOLVING INTRODUCTORY PHYSICS STUDENTS. Dennis A. Likens, Dept. of Physics, Tuskegee Univ., Tuskegee, AL 36088.

The Fall, 1987, Auburn University calculus based general physics laboratories (mechanics) were divided into four groups to determine if different laboratory instructional approaches affected the learning of mechanics concepts presented in lecture. A pretest and posttests over mechanics concepts were administered at the beginning, midterm and at the end of the course. The test scores were subjected to analysis of covariance. The calculated F-ratios were less than 1.0, resulting in acceptance of the null hypothesis: general physics laboratories in mechanics do not aid the learning of mechanics topics.

TWIN PRIMES. Aldo Forte, Department of Mathematics and Statistics, University of Alabama in Huntsville, Huntsville, Alabama, 35899

Twin Primes are prime integers whose difference is two. Between any pair of twin primes there is always a composite number. With the exception of the pair of twin primes 3 and 5, such a composite number is a multiple of six.

MEASURING WATER DEPTHS FROM SPACE. Mark A. Goforth, R. Kent Clark, Dept. of Physics, University of South Alabama, Mobile, AL 36688

Using multispectral digital imagery obtained from satellites, it is possible to measure water depths in coastal regions where the sea bottom is visible. Bathymetry in the vicinity of Key West, Florida is calculated from Landsat Thematic Mapper imagery with a general reflectance model. A multiple linear regression is performed against a set of known calibration depths on an IBM PC/AT to fix the free parameters in the model. Depths to 50 feet are calculated with an overall RMS error of 6.8 feet. This project was supported by the Mississippi-Alabama Sea Grant Consortium, grant number NA85AA-D-SG005.

## INDUSTRY AND ECONOMICS

CONSUMER BEHAVIOR OF BLACK COLLEGE STUDENTS: UNIVERSITY SELECTION.  
Marsha D. Griffin, Dept. of Mkt., AL A&M Univ., Normal, AL 35762.  
James G. Alexander, Dept. of Eco. & Fin., AL A&M Univ., Normal, AL 35762.

The purpose of this study is to investigate the consumer behavior of black college students as they move through the five steps in the consumer behavior model: problem recognition, information search, alternative evaluation, choice, and the outcomes of choice. The purchase studied was the choice of which university to attend. A convenience sample of 145 black students at Alabama A&M University (AAMU) provided the data for the study. When asked which factors were important in deciding to further their educations, the reasons receiving a rating of "very important" by the most students, in rank order, were to get a better job, to make more money, and to please their families. The reason ranked as "not considered" by the most respondents was to enhance their marriage prospects. Sources of information used in selecting a university which were rated as "very important" by the largest number of respondents were family and friends. The least helpful information sources were college directories and career days. When asked to assign an importance weight to factors used in evaluating alternative universities, students selected academic programs and tuition costs as most important. Reasons receiving the most votes of "not considered" were family members attended and extra-curricular activities. Some student choice re-evaluation is indicated by the facts that 17 percent have considered quitting school, 19 percent have considered "laying out" temporarily, and 22 percent have considered inter-university transfer. Nevertheless, three-fourths of the students plan to remain at AAMU, and almost the same percent are satisfied with their university selection, while only 10 percent plan not to continue and 15 percent are uncertain.

TIME FOR ACTION: CLASSIFY DIRECTORS AND ASSIGN ROLES. BENJAMIN B. GRAVES, DEPT. OF MGT & MKT, UNIVERSITY OF ALABAMA IN HUNTSVILLE, HUNTSVILLE, AL 35899.

Not since the great depression have we seen so many bankruptcies among American business firms, particularly financial institutions such as banks and savings and loan associations. The author believes these disturbing phenomena are due to two primary reasons; growing size and complexity of organizations and the physical and psychological overload on persons chosen as directors. A number of alternative solutions are examined such as part-time directors used in British corporations, the German model of co-determination, a quota system, public directors, professional directors, increased dependence on audit committees, ethics or government auditors. A model somewhat akin to that used by Texas Instruments is suggested as the most promising alternative. The latter has a three tier structure, namely Officers of the Board, General (or extra time) directors, and a third category simply known as a Director. Each of these categories is assigned a specific role in the board structure.

ALABAMA'S GRAIN MARKETING SYSTEM IN THE 1980'S, James L. Stallings, Dept. of Agricultural Economics and Rural Sociology, Auburn University, AL 36849-5406

Over the last 20 or more years the grain marketing system of Alabama has changed from mostly family owned country elevators and feed mills to collection stations and feed manufacturers for large vertically integrated poultry and other operations. Two large soybean processing plants in the northern part of the State provide the protein ingredient for the poultry operations. These two soybean processors recently have processed more soybeans than are currently produced in Alabama, necessitating importing soybeans into the State. In addition, a corn processing plant was established in Decatur in recent years necessitating importing more corn than would have been the case for only grain-consuming animals and a few other minor uses for corn. Alabama was a deficit state in all the five major grains studied in the project in 1985, except for grain sorghum, and it is expected to continue to be a deficit state in the near future. A 73 percent deficit in corn in 1985 is largely the result of the feed grain needs of a large poultry industry and the requirements of one large corn products processing plant. A 33.8 percent deficit in soybeans is largely due to the needs of two soybean processing plants in northern Alabama which processed over 40 million bushels in 1985 while Alabama production was only 27.8 million. Also, recent trends in the production of all the five grains have been downward since the 1985 survey on which the above figures are based while use continues approximately level to upward.

PREFERRED SOURCES OF FRESH FRUITS AND VEGETABLES AMONG INSTITUTIONAL BUYERS. Gerald Crawford, Professor of Marketing, Joe Free, Professor of Economics, and William S. Stewart, Professor of Management, School of Business, University of North Alabama, Florence, AL 35632.

Small farmers face many difficulties in marketing their fresh fruits and vegetables. High-volume canneries and commercial operations seem to prefer standardized products, special packaging, and handling, all of which are usually handled by large farmers but not by small farmer-suppliers. The present research focused on the needs of small retailers such as grocery stores, restaurants, and institutions that serve meals. It was hoped that a niche could be found that would encourage the direct purchasing of fresh fruits and vegetables from a local farmers' market.

Sixty-one local retailers were interviewed to determine their interests and needs. Most respondents place their orders with produce wholesalers by telephone. Overall, these retailers want (1) consistent quality, (2) consistent availability, (3) delivery, and (4) credit terms. While the idea of buying from a local farmers' market had some appeal, retailers seemed content to continue with present, proven purchasing patterns.

ENTREPRENEURSHIP AND ECONOMIC THEORY. Lawrence W. Lovik, Holder of the Adams-Bibby Chair of Free Enterprise, Troy State University, Troy, AL 36082

The mathematical economist Oskar Morgenstern in his article on "Thirteen Critical Points in Contemporary Economic Theory: An Interpretation," published in the Journal of Economic Literature, recalled a famous speech given in 1900 by David Hilbert regarding 23 unsolved problems in mathematics. Hilbert postulated that the solutions of these problems would lead to much progress. Although Morgenstern stated that he made no such claim to be to economics what Hilbert was to mathematics, he examined what he considered to be 13 crucial problems of economic theory. One of these was the topic of the entrepreneur and the theory of the firm. According to Morgenstern: "The firm currently presented in textbooks could be abolished and replaced by a computer. It has nothing to decide; there is only information of a specific kind to be gathered and the rest, finding a maximum, is automatically settled." Professor Morgenstern noted that the entrepreneur does not act as an automaton in a fixed and immutable environment. In a similar fashion, Professor William Baumol has remarked that although the entrepreneur is the most fundamental factor that determines the behavior of the firm, except for brief references "the theoretical firm is entrepreneurless-the Prince of Denmark has been expunged from the discussions of Hamlet." This paper examines the role of the entrepreneur in economic theory. The relationship between entrepreneurship and economic growth is also considered.

THE DYNAMICS OF CONSUMER ATTITUDE CHANGE:  
A LONGITUDINAL ANALYSIS. Keith Absher,  
Dept. of Marketing, University of North Alabama,  
Florence, AL 35632-0001, and C. P. Rao,  
University of Arkansas, Fayetteville, AR 72701.

The longitudinal framework of this study is structured around a survey that was mailed in February of 1983 (a few months after the repeal of blue laws in Arkansas) and a follow-up survey mailed in February of 1985 to the same individuals.

The attitude, intention, and behavior framework was chosen for this study because of the assumptions made by a number of consumer behavior models. These models depict a natural progression of attitudes leading to intentions which lead to behaviors.

The most significant finding of this study came from regression analysis. Those individuals with unfavorable attitudes, intentions, and behaviors in 1983 have changed their attitudes, intentions, and behaviors considerably by 1985. Those individuals that had favorable attitudes, intentions, and behaviors in 1983 have not changed those attitudes, intentions, and behaviors in any significant amount. This would indicate that exposure changes attitudes, intentions and behavior.

## Abstracts

WAGES AND BENEFITS IN THE SHOALS AREA: ESTABLISHING THE DATABASE. Paulette S. Alexander, Dept. of Management, Marketing and CIS, University of North Alabama, Florence, AL 35632-0001.

Of primary importance in the industrial development process is information on the prevailing wage rate and benefit practices in an area. Questions related to the specifics of labor costs rank among the five most frequently asked by companies considering locating in an area. Reliable wage and benefit data have not typically been available. The Shoals Industrial Development Authority, the Muscle Shoals Personnel Association and the University of North Alabama began a program in 1986 to establish a such a database.

The first phase of the program consisted of researching all available published and unpublished collections of data concerning wage rates and benefit policies. Since the data found were limited in scope and out of date, a determination was made to establish a comprehensive, up-to-date database through a survey process.

The second phase of the program has involved the completion of two surveys. The surveys asked for detailed information concerning benefit policies and actual wages paid to current employees. The first survey was sent to all manufacturing companies in two counties. The second survey was sent to major employers in government, education, health care and finance sectors in three counties.

While the response rate was adequate for these first surveys, plans are underway to improve the response rate and the accuracy of the responses for subsequent updates to the database. Benefits derived from the work done thus far include better responses to questions from industrial prospects and a better understanding of local labor force components and costs.

INCOME DISTRIBUTION IN ALABAMA: A HISTORICAL PERSPECTIVE. A. Wayne Lacy, Department of Economics, Auburn University at Montgomery, Montgomery, Alabama 36193-0401.

This paper examines the income distribution in Alabama for the last three census periods and compares changes within the state to changes made nationally in the equality/inequality of income. Lorenz curves of income distribution for Alabama are constructed for the years 1959, 1969 and 1979 and gini concentration ratios are compared with those of the U.S. Additionally gini ratios were calculated for the same years and show the changes occurring in the six major metropolitan areas of the state. Conclusions are that Alabama made considerable progress towards a more equal distribution of income from 1959 to 1969, but only small progress from 1969 to 1979. However this latter performance was significant in that it did not reverse the trend toward equality as happened in the U.S. overall. Progress differed substantially between six cities examined in the state with 1979 showing their gini ratios all closely grouped.

FIXING THE WORLDMINDEDNESS SCALE. David P. Campbell, Department of Management and Marketing, University of Alabama in Huntsville, Huntsville, AL 35899.

The Worldmindedness Scale was developed by Sampson and Smith (1957) to measure the attitudes of respondents along one major dimension, that of worldmindedness. A worldminded person uses mankind as the primary reference group, while an international-minded person may use some component of mankind, such as nationality, race, ethnic group, etc., as the primary reference group. Worldmindedness is independent of any topical knowledge about or interest in international relations. Sampson and Smith held that the construct of worldmindedness was composed of a number of subconstructs: religion, immigration, government, economics, patriotism, race, education, and war. The authors developed a 32-item questionnaire, each item of which was intended to measure the respondents' attitudes relative to one of the named subconstructs. Respondents were asked to respond to each item using a Likert-type scale, ranging from Strongly Disagree to Strongly Agree. Numerical scores were assigned to each response and the scores summed to yield a Worldmindedness Index. A higher Index indicates a higher degree of worldmindedness. The scale has been used to support research in marketing, international business, sociology, and social psychology.

The present research shows that the Sampson and Smith scale has serious shortcomings which preclude its use today. Those shortcomings are remedied. Using factor analysis, a shortened scale of nine items is developed and shown to measure the same worldmindedness construct measured by Sampson and Smith's 32-item scale.

DRG's AND NURSE STAFFING AND PRODUCTIVITY MODELING. Gene Grant, School of Business, Samford University, Birmingham, AL 35229. Joan Grant, School of Nursing, UAB; Lowell Broom, School of Business, Samford University; Chad Denson, School of Business, Samford University.

In this research, the authors have developed an innovative operations research approach to nurse staffing decisions in a hospital clinical setting. Due to the far reaching implications of a successful model of this nature, the researchers have decided to unveil the model at the Academy's annual meeting. Interested parties are requested to contact Gene Grant at Samford University for further information.

TRENDS IN CONSUMPTION AND MARKETING OF CATFISH IN THE SOUTHEAST. KERRY GATLIN AND GERALD CRAWFORD, DEPT. OF MARKETING AND MANAGEMENT, UNIVERSITY OF NORTH ALABAMA, FLORENCE, ALABAMA 35630.

Consumer concerns regarding negative health aspects of red meat coupled with recent publicity regarding health benefits of fish consumption has contributed to a sharp increase in consumption of catfish in the U.S. Contributing to this trend are (1) shifts in consumer consumption preferences and (2) the growing awareness within the catfish industry of the role of a well integrated strategic marketing plan for the industry.

Failure of the catfish industry to follow an organized, comprehensive marketing effort emphasizing consistency of quality, distribution, promotion and consumer convenience will limit industry potential.

This paper explores the trends with suggestions given for continued emphasis on comprehensive, industry wide marketing to further expand this growth industry. Special attention is called for to assure the industry adopt a 'marketing concept' as opposed to 'sales concept' marketing philosophy.

FURTHER CONSIDERATION OF ECONOMICS AS A SCIENCE. E. D. Chastain, Department of Economics, Auburn University, Auburn, AL 36849. Wayne C. Curtis, President, Abraham Baldwin College, Tifton, GA 31794.

Professional differences direct increased use of the procedures of science in solving imperfect knowledge problems in economics. Separation of empirical research from a priori knowledge is inherently needed. Symbolic mathematical communication in economics does not substitute for testing hypotheses and following other quantitative procedures associated with science. Incorporating such economic findings in a systems analysis framework suggests world benefit.



LEADERSHIP STYLES IN SECULAR AND SACRED LITERATURE  
H. A. Henderson

Management discussions in all types of enterprises generate tensions about who will control and the degree of control. Recent historical, social, and management studies generally conclude that structured self management is more effective in attaining group goals than control by autocratic leaders.

Participative, democratic, and collegiate management styles have clear origins in early Hebrew scriptures. Revealed truths suggest that God prefers to deal directly with responsive individuals rather than through others. But, freedom is limited by teachings of right and wrong. Free for good - not license for bad, is the gift of God.

Family based leadership was endorsed as the ideal with the father normally dominant. Prophets warned against kings "like the heathen nations". Examples of enduring "loose" and failing autocratic styles abound in early writings. Kings were anointed, but the system failed after prophesied abuse of power and corruption.

Terminology and method of management science and theology differ - but often disclose the same truths about man and society. Attempts to disperse power are in many activities of government and business. They are also in several religious organizations and movements such as "Shared Leadership", "Lay Renewal", "Priesthood of the Believer", and "The Emerging Laity".

USING ARTIFICIAL INTELLIGENCE IN MANAGEMENT. Maria V. Vitelli,  
Dept. of Business, Northwest Alabama State Junior College,  
Phil Campbell, AL.

Artificial Intelligence is rapidly working its way into the everyday lives of business managers. Within the broad field of artificial intelligence are two main groups: robotics and expert systems, the latter of which involves specific applications to the business environment. Since numerous expert systems have been implemented into the business arena, the concept of "artificial management" has been introduced. This study briefly reviews some of the capabilities of expert systems and their uses in the area of management. Specifically, the roles and tasks of an "artificial manager" are presented along with an eight stage development process for introducing artificial intelligence or the use of expert systems into a management environment. Further discussion on the effects of this technology on the corporate structure is also presented.

## Abstracts

DURATION: IS IT A TOOL FOR SMALL INVESTORS? Raymond M. Johnson,  
Department of Accounting and Finance, Auburn University at Montgomery  
AL 36193

The purpose of this paper is to illustrate the utility of the duration concept as a portfolio management tool for the small investor. The main thrust of the paper is to illustrate portfolio management techniques utilizing duration that are appropriately applicable for small investors who have limited knowledge and resources at their disposal. The more common immunization techniques are developed as well as methods to identify deep discount bonds that exhibit those characteristics consistent with portfolio objectives. Also, shortcut or rule-of-thumb techniques for estimating duration are explored. These techniques are useful for the small investor who does not find it feasible to invest in publications or computer programs providing these data.

INAPPROPRIATENESS OF ECONOMIES OF SCALE WITHIN THE MARKETING CONCEPT.  
Robert L. Sanders, Dept. of Marketing, Management, and Economics,  
Troy State University, Troy, AL 36082

Economies of scale have been used conceptually by both public and private sectors of the economy. Within the private sector, especially in manufacturing, the concept has been exploited for mass production, mass marketing, and mass consumption. The concept also resulted in some theorists predicting the "doom of large scale advantage" in the U.S.A.. This paper explores the appropriateness of the concept of economies of scale in a dynamic environment moving from manufacturing, marketing, and consumption of goods to the production, marketing, and consumption of services. Particular emphasis is given to the change from mass marketing to target marketing of professional services in health, law, and accountancy and the task of synchromarketing.

THE IMPACT OF LIABILITY INSURANCE ON ALABAMA PHYSICIAN PRACTICES.

Donald R. Self, Teri A. Kline, and Jerry Ingram, Department of Marketing, Auburn University at Montgomery, Montgomery, AL 36193-0401.

Increasing Liability Insurance rates have had profound influence on the availability of medical treatment. The results of a survey of Alabama physicians conducted immediately before the passage of the 1987 Tort Reform Laws documents changes in services offered, prices charged and various office practices.

THE EFFECTS OF TIMING OF STOCKING, HARVESTING AND MARKETING STRATEGIES ON PROFIT MAXIMIZATION IN CATFISH FARMING. Curtis M. Jolly, Dept. of Ag. Econ. and Rural Soc., Auburn University, Alabama, 36849-5406. Carole R. Engle, Economics Dept., Auburn University at Montgomery, Montgomery, Alabama 36193-0401.

Production, management and marketing strategies for an average catfish farm in Alabama were simulated, using a dynamic linear programming model. The production factors analyzed included the stocking rate, length of production period, and size of fingerling stocked. The management and marketing parameters comprised immediate sales to processors, overwintered fish, direct sales to consumers, and fish-out operations. Sensitivity analyses were conducted to evaluate changes in direct sales and fish-out market constraints, levels of operating and investment capital, frequency of occurrence of off-flavor in market fish, the farmgate price of fish, and purchased price of fingerlings, on net farm income. The model results indicated that the most profitable management strategy was to stock 4-6 inch fingerlings at 8000/acre for harvest in the fall. Direct sales and fish-out operations enhanced farm profits, but sales were constrained by proximity of the farm to urban centers. The additional unit cost of overwintering fish was greater than the spring-fall per unit fish price differential. High percentages of off-flavor fish in the fall, however, required farmers to overwinter stocks and accept reduced farm income. The least profitable strategy was to stock large (7-8" fingerlings) for harvest in July. A lower summer farmgate price and increased fish mortality due to handling in hot weather resulted in reduced profit margins. The authors are grateful to Drs. Jensen and Crews of the Alabama Cooperative Extension Service for valuable suggestions.

TAXATION IN MID-NINETEENTH CENTURY ALABAMA. Jan R. Heier, Auburn University at Montgomery, Montgomery, AL 36193-0401.

During the period 1850-1870, the State of Alabama underwent drastic changes in its societal structure and economic environment. These changes also impacted the state's philosophy of taxation. Prior to the Civil War, Alabama's tax Revenue from an Ad Valorem property tax on real and personal property. The antebellum tax laws also provided for taxation on gross receipts of various professions as well as a system of tax licensing to regulate certain activities of the public like horseracing. The Civil War period brought changes in the tax structure with higher rates and the advent of a tax on business profits based on both an economic and accounting definition of income. The problems of the War and a devalued Confederate currency led to a "payments in kind" method of settling a tax liability. The Post Civil War period saw a return to lower rates but a revision in the income tax laws to include individual incomes to offset lost property tax revenues from the emancipation of the slaves. In all three periods, there existed a or head tax levied on each male (black or white) in the population with revenues earmarked for education.

STRATEGIC PLANNING AS A MANAGEMENT DEVELOPMENT TOOL. William I. Sauser, Jr., Office of the V.P. for Extension, Auburn Univ. AL 36849.

Managers at all levels of an organization perform four essential functions. They anticipate the future and plan courses of action; they organize resources and direct their use to accomplish established objectives; and they compare accomplishments against objectives to control organizational functioning.

Each level of management has its own planning horizon, with top management having the broadest horizon. As managers move through the organizational hierarchy, the mix of skills necessary to succeed shifts. While human relations skills remain important at all levels, conceptual skills become relatively more important than technical skills at the higher levels of management.

When lower-level managers move into higher levels of authority, it is often necessary for them to improve their conceptual skills. One technique for developing conceptual skills is participating in strategic planning exercises. Strategic planning - the construction of a roadmap for the future of an organization - requires such actions as environmental scanning, analysis of external opportunities and threats and internal strengths and weaknesses, and production of plans and priorities.

The author recently used strategic planning exercises to develop management talent in two organizations, a higher-education unit and a state agency. In both cases the strategic planning process proved beneficial as a management development tool.

MEASUREMENT THEORY AND ITS IMPACT ON ACCOUNTING. David L. Sayers, Department of Accounting and Finance, Auburn University at Montgomery, Montgomery, AL. 36193.

The terms "measure" and "measurement" appear frequently in accounting literature, yet very few academicians have addressed the issue of measurement theory and its relation to accounting theory and practice. An examination of the accounting literature reveals that theory construction and confirmation and measurement theory are strongly intertwined. Accounting may not be a strict measurement discipline. Instead, it can perhaps be best described as a "quasi-measurement discipline." Can accounting become a measurement discipline? The answer is probably a conditional "yes." Given that theory construction and confirmation and measurement theory are inseparable in the empirical sciences, the development of measurement theory in accounting must accompany the development of accounting theory.

PERSPECTIVES FOR RURAL CHANGE IN THE TENNESSEE VALLEY  
H. A. Henderson and John E. Culp, Agricultural Institute, TVA

Changes in rural communities are of enduring national and regional concern. TVA has been involved in such changes, working with other organizations, especially the land-grant universities and USDA, since 1933. It uses integrated approaches to regional development.

In the past 50 years, new fertilizers have been developed, new technology introduced, farms diversified, electricity provided, food production increased. Yield increases include: Corn up 155 percent. Cotton up 62 percent. Crops were diversified. Sales per acre of cropland harvested are up 500 percent. Total farm sales are up 200 percent. While production was being increased, about half of the land and labor resources were released for nonfarm development. Real sales per acre of cropland harvested have gone from 47 to 130 percent of the nation.

The Agricultural Institute was formed by TVA in 1986 to guide rural change in the region. The work is organized in four areas: (1) Jobs and Income; (2) Natural Environment; (3) Technology; and (4) Alternative Enterprises. Programs still evolve. New programs include erosion control, vegetable marketing, pollution control, and alternative enterprises. Planning for change continues to search for programs for the future. Interested citizens and agencies are invited to participate in the planning and programs.

MALL VERSUS FREESTANDING RETAIL OPERATIONS: A CONSUMER ANALYSIS. Keith Absher, University of North Alabama, Florence, AL 35632-0001.

In this study a comparison was made of customers of freestanding retail stores and mall retail stores. Stores were selected on the basis of having both a free standing retail and a mall retail operation in the same Standard Metropolitan Statistical Area.

Intercepts were used to administer 100 consumer surveys to consumers entering each of three matched sets of stores used in this study (sporting goods stores, department stores, and electronics stores) for a total of 600 surveys.

Mall customers were more likely to classify themselves as (1) recreational shoppers, (2) not having a definite purchase in mind, and (3) just looking. On the other hand, freestanding store customers were more likely to classify themselves as (1) having a definite purchase in mind, (2) service oriented, and (3) looking for a particular brand of product. These findings could have implications for retail in the following areas: product mix, sales training, sales promotions, retail displays, advertising, pricing, and store design.

DO U.S. TRADE DEFICITS MATTER? MARKETS SEEM TO THINK SO. Charles E. Hegji, Dept. of Economics, Auburn Univ. at Montgomery, Montgomery, AL 36193.

The paper examines the response of six major U.S. dollar exchange rates to the Department of Commerce's monthly announcements of the U.S. balance of merchandise trade over the period 1980 to mid-1987. Movements in these foreign exchange rates on the day of the balance of trade announcements are regressed against both the anticipated and unanticipated components of the Commerce Department's announcements, in addition to the Index of Leading Economic Indicators and the 30-day forward exchange rate premium. These latter two variables serve, respectively, as proxies for real economic conditions and the difference between United States and foreign interest rates. The anticipated announcement is obtained using Money Market Service's estimate of the market expectations of the balance of trade announcements. We find that prior to 1985.3 there is no significant response in exchange rates to the trade announcements. On the other hand, during the period 1985.3 to 1987.7, all foreign currencies with the exception of the Japanese Yen and Canadian dollar respond to the trade announcements. Furthermore, the response to a positive announcement in all cases is a depreciation of the dollar relative to the foreign currency. This holds independent of the behavior of the proxies for interest rates and real economic activity. Finally, markets are shown to be efficient in responding only to the unanticipated component of the trade announcements.

PASSIVE LOSS LIMITATIONS: EFFECTS ON TAX PLANNING. Samuel L. Lett, Dept. of Accounting and Finance, Auburn Univ. at Montgomery, Montgomery, AL 36193.

Tax shelter investments generating losses have long been used by taxpayers to offset income from other activities such as salaries. Congress, concerned that extensive tax shelter activity contributed to the idea that the tax system was unfair, enacted the passive loss limitation rules as part of the 1986 Tax Reform Act. Passive activities generally include investments in which the owner is not a material participant, investments in limited partnerships and investments in real estate activities. An exception exists for real estate which allows the use of up to \$25,000 in losses to offset ordinary income for some taxpayers. The rules limit using passive losses to reduce the taxable income of the taxpayer from non-passive activities. Initially tax planning should center on insuring the taxpayer is a material participant in the activity. Barring material participation, the key to tax planning is to invest only in activities which have the expectations of generating real profits. A third key is if passive losses exist, search for passive activities which generate gains. Recent restrictions passed by Congress on exotic tax vehicles such as master limited partnerships indicate that the government is intent on limiting the tax advantages of tax shelters.

SCIENCE EDUCATION

GIFTED, ACCELERATED, AND TALENTED HIGH SCHOOL STUDENTS AT JACKSONVILLE STATE UNIVERSITY. R. Earl Poore, Department of Chemistry, Jacksonville State University, Jacksonville, AL 36265.

A program for gifted, accelerated, and talented students was conducted at Jacksonville State University during the summer of 1986. Sixty (60) 8-11 grade students lived on the campus for one month and took four different courses, especially designed for them, from the disciplines biology, chemistry, history, political science, art, music, literature, and drama. This program was funded by a grant from the Southern Studies Program at Jacksonville State University.

SPACE PROBES AND VEHICLES: WHAT IS LAUNCHED AND HOW CAN WE USE THE INFORMATION IN SCIENCE EDUCATION? Ernest D. Riggsby, Columbus College, Columbus, GA 31993-2399.

A summary look at the twelve major space launch centers worldwide and a consideration of some of the useful information which has come from those centers and their hardware launches. Examples and suggestions for using appropriate data and information from such centers and launches in the middle school science curriculum. Weather, global geography, ecology and natural resources are among the science curriculum areas focused upon.

HONORS SCIENCE COURSES FOR TALENTED STUDENTS: PIAGET, CHEMISTRY, RECOMBINANT DNA. Larry Rainey, Elaine Martin and Jonnie Skinner, College of Community Health Sciences, University of Alabama, Tuscaloosa, AL 35487

The University of Alabama's Macy BioPrep Program has been instrumental in the development and implementation of honors science courses for talented students in 33 high schools in west Alabama. At present, Biology, Chemistry, Physics and Anatomy and Physiology courses are offered. Innovative components include recombinant-DNA technology in the Biology curriculum, while the Chemistry course incorporates Piaget's learning cycle theories.

This paper discusses how these innovative techniques are incorporated into high school classes and laboratory activities.

THE EFFECTS OF IMMEDIATE ACHIEVEMENT AND RETENTION OF STUDENTS INVOLVED IN A METRIC UNIT DESIGNED TO PROMOTE THE DEVELOPMENT OF ESTIMATING SKILLS. Robert E. Rowsey, Department of Curriculum and Teaching, Auburn University, AL 36849.

Three hundred ninety-seven seventh grade students were studied to determine the effect on immediate achievement and retention of a unit designed to promote the development of estimating skills involved in metric measurement. The study involved five teachers with a total of fifteen average or advanced level classes divided into the reference and treatment groups. A 5-day metric unit was designed so that both groups received exactly the same instruction in metric length, mass, and capacity with the exception of the treatment group's participation in activities relating to the development of estimation skills. Data collected from the Metric Application Instrument and analyzed with Analysis of Covariance indicated that students in the experimental group did retain significantly more of their improved metric application skills than the students in the reference group. The analysis of the main effects of race, sex, and ability indicated that white students achieved significantly more than black students and that males achieved significantly more than females. Analysis of significant race/ability and sex/race interactions indicated that: (a) white students in the advanced group attained significantly greater achievement in metric application skills than black students of equal status, and (b) white males significantly retained their metric applications achievement when compared to black males or black or white females.

HISTORIANS, PRACTITIONERS, RESEARCHERS, AND PHILOSOPHERS.

Raymond E. Isbell, Ph.D., Department of Chemistry, University of North Alabama, Florence, AL 35632.

Teachers, and most other professionals may be classified as historians, practitioners, researchers, and philosophers. Historians teach about what is already known; practitioners teach students to use existing information for a practical purpose; researchers, using analogy and instruction, teach students to apply known principles to new situations thereby generating new information; and philosophers, using known information and logic, establish theories pertaining to some area of experience. Teaching and learning involve all of these and the teacher who doesn't recognize this may seriously short-change the student.



A SURVEY OF ALABAMA SECONDARY SCIENCE TEACHERS' NEEDS  
William E. Baird , Department of Curriculum & Teaching,  
Auburn University, Auburn, Ala. 36849-3501

A 54-item needs assessment was distributed during March, 1987 to 1870 teachers responsible for 7 - 12th grade science instruction in Alabama. Teacher and school demographic information was obtained. A rank ordering of the 54 needs by the 797 responding teachers indicates that teachers are most interested in motivating students, locating sources of free and inexpensive instructional materials, learning to use computers, evaluating their own instructional effectiveness, and upgrading their knowledge in specific science domains. Teachers are least interested in learning more about clerical activities, student evaluation, instructional planning and working toward a graduate degree. Primary barriers to increased participation in inservice activities were found to be inconvenient location, poor communication of scheduled programs, and lack of personal energy. The existence of these barriers implies that even the best efforts to match teacher needs and inservice programming may not result in greater involvement by secondary science teachers unless other concerns are met first.

SOCIAL SCIENCES

RURAL CRIME: VICTIMIZATION & PREVENTION. Gladys J. Lyles,  
Dept. of Sociology, Tuskegee Univ. Tuskegee, AL 36088

Despite substantially lower victimization rates for women in most crime categories, gender consistently emerges as one of the most powerful indicators of fear of crime. This paper examines gender, place of residence and perceptions of fear of crime in Alabama. In this preliminary analysis other related factors are examined such as seriousness of crime in local communities, victimization experiences and crime prevention strategies. This research is part of a southern regional project on crime victimization and prevention. Data were collected from questionnaires mailed to a state-wide sample of 3,500 registered motor vehicle drivers in Alabama; 1639 were returned. These results are consistent with other research findings which show gender differences of fear of crime and victimization experiences. Gender differences also exist in crime prevention strategies.

VARIATIONS IN PARTICIPATION IN GOVERNMENT SERVICES BY FARMERS IN ALABAMA. Joseph Befecadu, Hezekiah Jones and Gerald Wheelock, Dept. of Agribusiness Education, Alabama A&M University, Normal, AL 35762.

The study was structured to assess participation in government services among farmers in Alabama. A random sample of 141 farm operators was selected from two systematically selected counties. The CES, FmHA, and ASCS were the agencies selected for this study. A survey instrument was developed to collect data by personal interview. Data analysis included frequency distribution and chi-square analysis. The results showed that there was a significant difference in participation by small and large farmers in all three services. Small farmers use these services less than the large farmers. County, race, age, sex, and education had no significant effect on participation. Controlling for age, and looking at size, the analysis showed that in both age groups there were significant differences, only in the younger age group. In all cases small farmers use less of these service than large farmers. Controlling for race and comparing participation by size, there were no significant differences for blacks in any of the services. However, there were significant differences in participation by small and large white farmers for FmHA and CES, with small farmers using these services less than their large counterparts. Controlling for education and comparing participation by size, there were significant differences between small and large for CES for both levels of education, and for FmHA in the high school and below only category. In all cases, small farmers use these services less than large farmers. Although, there were several sources of information about these services given by respondents, friends and relatives were the major source. Finally, comparing reasons given for nonparticipation in the services, "not needed" was by far the dominant factor.

A FORCE FIELD OF POLITICS: THE CASE OF THE EQUAL RIGHTS AMENDMENT. V. Lynne Windham, Dept. of Political Science & Public Affairs, Univ. of Ala. at Birmingham, University Station, AL 35294.

The ERA was first introduced to Congress as a proposed amendment to the U.S. Constitution in 1923--three years after the passage of the Nineteenth Amendment granting women the right to vote. Yet, the ERA, granting equality of rights to women, was not passed by Congress until 1972. In 1972, twenty-two states ratified the ERA. Despite its early success and despite continued majority public support, the ERA failed to pass, receiving no state votes after 1977. Understanding what went wrong in the policy process of adopting the proposed ERA is to identify forces in its political force field. Four forces exerted differential pressure on the ERA during its time in the policy process: the implementation controversy, the legal implications, the information dissemination, and the interest group involvement. Successful passage of the ERA would have required the proponents to manipulate each force in their favor. However, passage of a controversial amendment is a complex process vulnerable to destructive elements. In the force field of politics surrounding the ERA, the opposition was able to mobilize enough destruction.

INMATE CLASSIFICATION: IMPLICATIONS OF TYPE I AND TYPE II ERRORS.  
William E. Osterhoff, Auburn Univ. at Montgomery, Montgomery, AL 36193.

Corrections in the United States is in a state of crisis. In spite of new institutions, increased funding, and growing professionalism, correctional administrations continue to be faced with crowding, insufficient staffing and programs, and ongoing litigation. A record average daily population of more than 500,000 inmates are incarcerated in the nation's prisons and more than 230,000 inmates are being held in local detention facilities (Bureau of Justice Statistics, 1986). An integral component of a correctional institution is the inmate classification system which can exert an important influence on the inmate population. In general, the "correct" inmate classification would be the least restrictive custody level consistent with necessary inmate control and public safety. Each classification decision is subject to two potential types of errors, "over-classification" and "under-classification." In terms of statistical hypothesis testing and decision making, overclassification, or classifying a true low risk offender as a high risk offender, would be considered a false positive or a Type I classification error. Underclassification, or classifying a true high risk offender as a low risk offender, would be considered a false negative or a Type II classification error. Neither type of classification error is consistent with good correctional management. An undesirable consequence of Type I classification errors is a tendency to create conditions in a correctional institution which lead to a cycle of more overclassification and more overcrowding. An undesirable consequences of Type II classification errors is an increased risk of the commission of additional crimes.

THE COMMUNICATION ARENA: TRENDS AND ISSUES. TAMRAT MEREBA, DEPT. OF COMMUNICATIONS MEDIA, ALABAMA STATE UNIVERSITY, MONTGOMERY, AL 36195.

Toward the end of the 1970s and the first half of the current decade, a flurry of technological changes and possibilities swept the communication arena bringing with them new ways and strategies for gathering, storing, processing and disseminating information. The characteristics of these technological changes reflect not only the increase in new products and services at a rapid pace but also issues of wider social magnitude arising from the "information revolution" and affecting the social, political, economic and cultural spheres of the increasingly information - dependent society of the west. Looking into the future, matters are not clear in determining the level and extent of changes that might occur in our information environment. Governmental regulation and contradictory and often competing social and political forces arising from changing social circumstances are likely to influence the direction of the "information revolution". For regulators, however, preserving working communication systems and fostering their new improved replacements without causing undue waste and confusion will be a challenge in the face of mounting social and political currents.

POWER IN URBAN COALITIONS. David W. Sink, Dept. of Political Science and Public Affairs, Univ. of Ala. at Birmingham, 35294.

The thesis of this paper is that community-based policy coalitions, composed of policy entrepreneurs and organizers, are able to cause or take advantage of triggering mechanisms to create "policy windows" through which highly symbolic valence issues are able to be translated into concrete proposals and subsequent public policies. However, they may fail as well if triggering mechanisms are absent, if these policy entrepreneurs are unable to create adequate interest and support for their issues, if they fail to follow-through on issues of concern, or are unable to affect policymaking at other levels of government. Urban coalitions can be effective as influences on the urban policy agenda; nonetheless, they must be able to influence or control other variables that effect the policy agenda.

ROLE OF TRIBAL GOVERNMENTS IN THE U.S.. Susan P. Demitz, Dept. of Political Science and Public Affairs, Univ. of Alabama at Birmingham, Birmingham, AL 35294.

Tribal governments of Native Americans have traditionally been ignored or encouraged by the U.S. Federal Government. The role of those governments in the U.S. political system has ranged from non-existent to minimal. The enactment of the Indian Self-Determination Act of 1975 and the Reagan Administration's Indian Policy have now given tribal governments more recognition and power. The expansion of the role and some of it's effects on the tribes themselves will be discussed.

HAZARDOUS WASTES AND COMMUNITY DECISION MAKING. Conner Bailey, Dept. of Agricultural Economics and Rural Sociology, Auburn University, AL 36849-5406.

Hazardous waste management is a problem facing both urban and rural communities. Rural communities are relatively unprepared, technically or politically, to play an active role in decisions on siting a hazardous waste facility. Where such facilities already exist, rural communities are easily dominated by powerful corporations or state and federal regulatory agencies involved in the handling or disposal of hazardous wastes. These problems are illustrated with reference to Sumter County, Alabama, location of the nation's largest hazardous waste landfill facility.

DEVELOPMENT OF A SCALE TO MEASURE TECHNOSTRESS: COMPUTER RELATED STRESS.  
Richard A. Hudiburg, Dept. of Psychology, Univ. of North Alabama,  
Florence, AL 35632-0001.

The focus of this study was to develop a scale to measure technostress or computer related stress. This scale was called the Computer Technology Hassles Scale (CTHS). The CTHS was based on the idea that certain interactions with computer technology are perceived by people to be stressful or a "hassle." A list of 65 "hassles" was given to a sample of 141 undergraduate and graduate college students. Each subject was to rate the hassle's degree of severity using a graded response. To ascertain the relationship of the CTHS to other measures, the subjects were given the 14 item Perceived Stress Scale (PSS) to measure global stress and the 20 item Computer Attitude Scale (CAS). Demographic data on each subject was also collected.

The scoring of the CTHS yielded a total hassles score, a total severity score, and an intensity score. The PSS and CAS were scored to obtain overall measures of stress and attitudes toward computers. The three CTHS scores were correlated with the PSS and CAS scores, as well as the demographic data. The correlations revealed a high redundancy between the three CTHS scores, so the CTHS total hassles score was used for further analyses. The correlation analyses showed that the CTHS was significantly correlated with the global stress score (PSS) and the number of hours of computer use. The CTHS was independent of attitudes toward computers. The relationship between the CTHS and PSS suggests that the Computer Technology Hassles Scale (CTHS) taps a dimension of psychological stress. The CTHS relationship to hours of computer use indicates that increased computer use for some people leads to increased computer related stress.

#### AIDS IN THE WORKPLACE: SUMMARY OF RESEARCH FINDINGS.

Joseph F. Huggins and James A. Johnson, Dept. of Political Science,  
Memphis State University, Memphis TN 38152

A growing concern for employers, managers, administrators, human resource professionals, personnel staff, and supervisors is how to prepare themselves to deal with an employee, or employment applicant, who has contracted AIDS (Acquired Immune Deficiency Syndrome). The number of AIDS cases to be diagnosed during the next four years is projected to be four times the total of all AIDS cases diagnosed to date. With 85% of the future AIDS cases occurring among males and females between the ages of 20 and 40, who are either employed or are seeking employment, the possibility that organizations will encounter one of these persons is increasing rapidly. However, most organizations are not developing any formalized policy or procedures for use in the event they are faced with an employee or job applicant with this disease. This review of the literature on AIDS in the workplace presents the scope of the problem; identifies workplace issues that have developed, are developing, or may develop; discusses organizational responses that have been made; and provides recommendations to organizations for developing sound policies and procedures for managing AIDS in the workplace.

BECCARIA AND THE BILL OF RIGHTS. Darrell L. Schlotterback, Dept. of Justice and Public Safety, Auburn Univ. at Montgomery, AL 36193.

Cesare Beccaria's book of essays, on Crimes and Punishments, published in 1764, was truly a product for the times and it fostered both revolutionary and evolutionary change in continental Europe, England, and the American Colonies - soon to be the United States. Beccaria's work was known by our nation's founding fathers and it had an impact upon shaping the causes of our American revolution and the framing of our Constitutional form of government. But more than that, in classic fashion, the essays of Beccaria still relate to the Constitutional debates of these modern times. Beccaria wrote of laws that forbid the conveying of arms, a matter addressed in the second amendment. He is generally credited with the "glory of having expelled the use of torture from every tribunal throughout Christendom," a matter addressed in the eighth amendment both from the standpoint of cruel and unusual punishment and proportionality. He also wrote of concern for the plight of the unmarried pregnant female, a dynamic constitutional issue in modern America. These areas are explored to introduce you to two important and related classical documents: The Constitution of the United States and Cesare Beccaria's On Crimes and Punishments.

POLITICAL REGIMES AND DEVELOPMENT ADMINISTRATION IN AFRICA.  
J. B. Jimmeh, Dept. of Political Science, Tuskegee University,  
Tuskegee, AL 36088.

Political regimes and development administration present varying degrees of compatibility for purposes of social development. Generally, the ethos of political regimes and the requirements of change-oriented administration are conflictual and problematic. In Africa especially over the past thirty years, since independence (late 1950s), different political projects, fused with the same ideology of development, have been undertaken. In spite of the variety of political experimentations on the continent, however, the record of underdevelopment is commonplace, and questions of "good government", "representation", and "accountability" persist within/about the dominant patrimonial administrative state in Africa.

The Legislative Veto: An Alternative Deterrent to Governmental Abuse. Walter S. Williams, Tuskegee University, Tuskegee, AL 36088.

The legislative veto is one of the most essential devices of legislative oversight. Oversight of the bureaucracy is essential if the decisions made by Congress are to have any force. Congress may use the legislative veto in its oversight function as a central means by which Congress can secure accountability of executive and independent agencies.

VARIATIONS IN PARTICIPATION IN GOVERNMENT SERVICES BY FARMERS IN ALABAMA. Joseph Befecadu, Hezekiah Jones and Gerald Wheelock, Dept. of Agribusiness Education, Alabama A&M University, Normal, AL 35762.

The study was structured to assess participation in government services among farmers in Alabama. A random sample of 141 farm operators was selected from two systematically selected counties. The CES, FmHA, and ASCS were the agencies selected for this study. A survey instrument was developed to collect data by personal interview. Data analysis included frequency distribution and chi-square analysis. Data analysis showed that there was a significant difference in participation by small and large farmers in all three services. Small farmers use these services less than the large farmers. County, race, age, sex, and education had no significant effect on participation. In both age groups there were significant differences, only in the younger age group. In all cases small farmers use less of these services than large farmers. Controlling for race and comparing participation by size, there were no significant differences for blacks in any of the services. However, there were significant differences in participation by small and large white farmers for FmHA and CES. Again, small farmers use these services less than their large counterparts. Controlling for education and comparing participation by size, there were significant differences between small and large for CES for both levels of education, and for FmHA in the high school and below category only. In all cases, small farmers use these services less than large farmers. Although, there were several sources of information about these services given by respondents, friends and relatives were the major source. Finally, comparing reasons given for nonparticipation in the services, "not needed" was by far the dominant factor.

CHILD ABUSE: THE VICTIMIZATION PROCESS. Lyle L. Shook and William E. Outerhoff, Dept. of Justice and Public Safety, Auburn Univ. at Montgomery, Montgomery, AL 36193.

Child abuse refers to any act of omission or commission that endangers or impairs a child's physical or emotional health and development. While there are several forms of child abuse, this paper focused on the sexual abuse of children. Child abuse and exploitation occurs in all elements of society and is usually the result of a number of interrelated factors and circumstances. Characteristics and behaviors that are common to child sex offenders were discussed as were factors that frequently are found among child sex abuse victims. The victimization process usually involves enticing and manipulating children who for various reasons are susceptible to their offenders. Once involved in the victimization process, however, the child may be coerced and manipulated into continuing the relationship with the offender under conditions of relative secrecy from other adults. There are also instances where children are sexually abused through force or the threat of force. The short and long term effects of sex abuse on children and methods of providing assistance to the victims were discussed. Methods of dealing with the offenders also were referred to.

RESTITUTION: A HOLISTIC APPROACH TO THE ESTABLISHMENT OF A COUNTY-WIDE PROGRAM. Sue B. O'Neill, District Attorney's Office, 15th Judicial Circuit, Montgomery, AL 36104

Historically, the concept of restitution pre-dates the Old Testament. Alabama Law incorporated the concept as early as the 1930's where restitution was required as a condition of parole. However, little was done until the early 1980's when additional legislation was passed which authorizes restitution to fully compensate all victims of crime. It is clear from this new enactment that it is the intent of the legislature that victims be fully compensated through restitution. Under "Criminal Procedure" - section 15-18-142, the Code of Alabama defines restitution as "an amount of money ordered by a court to be paid to a clerk or other person by a defendant for the use and benefit of a victim for the defendant's criminal offense." Restitution serves a two-fold purpose, to compensate the victim, and to hold the defendant accountable for his actions. The Montgomery County District Attorney's Office is taking a holistic approach to the establishment of a county-wide program which includes both the Adult and Juvenile Courts. This approach entails working with all facets of the restitution process and coordinating efforts as well as combining resources on the local, state and national levels. As a result of this approach, a pilot project conducted with Circuit Court Judge Mark Kennedy's delinquent restitution cases increased the average monthly collection rate in these cases by 147%.

JUSTICE, FAIRNESS, AND THE IDEAL OBSERVER. Lawrence J. Hanks, Department of Political Science, Tuskegee University, Tuskegee, AL 36083.

Man's longing for moral agreement has lead many philosophers to focus on the metaethical question: "What do we mean by "X"? Despite the attention, a comprehensive agreement has not been reached concerning the best method for establishing the meaning of ethical terms; reasonable men continue to differ regarding the meaning of "x," i.e., what is "good," "bad," "right," "wrong," etc. etc.

This paper argues that the ideal observer theory provides the best answer to the metaethical question. The argument rests on two basic premises: (1) there are a number of obstacles that keep individuals from making truthful judgements. Chief among them are ignorance, self interest, and ideological commitment; (2) the ideal observer theory recognizes these obstacles and takes them into account in the development of the ideal observer criteria.

The ideal observer is one who is omniscient, omnipercipient, dispassionate, disinterested, consistent, and "normal" in all other respects. These qualities allow the ideal observer to become objective-- objectivity leads to truthful, unbiased, ethical statements.



INDIVIDUALS' RATINGS OF CHARACTERISTICS OF THEIR GIVEN NAMES AND THEIR INTERCORRELATIONS. Charles E. Joubert, Dept. of Psychology, Univ. of North Alabama, Florence, AL 35632.

Despite occasional opinions regarding the importance of given names and observations of their relationships with adjustment factors, the dimensions on how persons evaluate their own names has been infrequently studied. This research asked university students to rate their first and middle names on seven dimensions: importance, unusualness, attractiveness, sex-appropriateness (masculinity or femininity), personal appropriateness, and distinctiveness, as well as to indicate how well they liked them. Both males and females appraised their first names as more important, attractive, personally appropriate, and distinctive than their middle names; moreover, they liked their first names better. Females tended to regard both of their names as more sex-appropriate than did males theirs. Also, the "unusualness" dimension possessed a significant sex X names interaction. Persons who liked their names tended consistently to view them as more important, attractive, distinctive, and personally appropriate. Additionally, those who regarded their names as personally appropriate also viewed them as important, attractive, and distinctive. Males who felt they had unusual first names also tended to regard them as less sex-appropriate. Men were more likely than were women to indicate that they would give their first names to a child. People who said that they would give someone else their first names tended to like them better and to view them as more important and distinctive.

PRIVATIZATION IN CORRECTIONS. Marilyn Mashatt, Auburn University at Montgomery, Montgomery, AL 36116.

The get tough "law and order" policies of the past decade combined with the prevailing American ideal of retribution have resulted in overcrowding in America's prisons. In addition to overcrowding, the costs of running prisons is a monumental problem; expenses continue to escalate. Neither the government nor the public want to spend additional tax dollars for prisoner upkeep, let alone prison construction. Privatization is seen as a viable means to augment public corrections and help the overcrowding and expense burdens on both prisons and communities. Various studies on the subject of privatization in corrections have been undertaken, resulting in recommendations that need to be considered when contracting with private companies for correction services. Prominent among these is security responsibilities, obligation to protect inmates, state and local government liability and inmate selection criteria. Although privatization is not a "quick fix" for what ails our prisons and correctional systems, it can apparently be of some help as an option to complement public corrections.

HEALTH SCIENCES

CLONING OF DNA FRAGMENTS OF A MURINE ADENOVIRUS PLAQUE TYPE VARIANT. Kevin W. Brown and A.L. Winters, Dept. of Microbiology, Univ. of Alabama, Tuscaloosa, AL 35487

A plaque type variant of strain FL mouse adenovirus (MAdlpt4) forms cytolytic (clear) plaques and induces hemorrhagic lungs and death in mice when injected intraperitoneally. This virus strain is currently being used in a laboratory model to study adenovirus pathogenesis. Several fragments of the MAdlpt4 genome were cloned using the pUC18 cloning vector. Cloned fragments include the HindIII B, D, and E fragments which comprise approximately forty percent of the viral DNA.

A second mouse adenovirus strain (MAV-1/SL) isolated by Larsen and Nathans does not induce hemorrhagic lungs and has been mapped with DNA restriction enzymes. We have compared the restriction maps of MAdlpt4 with MAV-1/SL. The two viruses have identical restriction maps with the exception of an apparent small insertion (45-90 base pairs) at one end of the MAdlpt4 genome. This insertion can be demonstrated in the HindIII F fragment as well as the BamHI D fragment of the MAdlpt4 DNA molecule. If the gene organization of mouse adenovirus is similar to human adenovirus, then the MAdlpt4 insertion maps within either the E1 or the E4 transcription unit depending on the disputed orientation of the mouse adenovirus map. Human adenovirus mutants mapping within the E1 region, a region required for host cell transformation, demonstrate clear plaques and a deficiency in their ability to transform cells. Thus, MAdlpt4 may reflect an insertional inactivation of an E1 region gene or genes. The fine-scale mapping of the insertion region will be difficult due to its location near the terminus of the molecule. Attempts are now under way to clone segments of the DNA near the site of insertion using SmaI.

SCHIZOPHRENIA DISTRIBUTION WITHIN THE STATE OF ALABAMA. Sheila A. Hopper, Dept. of Nursing, University of Alabama at Birmingham, Birmingham, AL 35294. Sheila Hopper, Rainsville, AL 35986.

A study was conducted to compare the incidence of schizophrenia within the state of Alabama. Data were collected from the State Department of Mental Health and Mental Retardation and a comparison was made of the number of diagnosed cases of schizophrenia of each mental health center within the state. Higher incidences of schizophrenia were found in the larger, more industrialized cities and the areas serving a higher number of blacks than whites.

NEEDS OF ADULT CANCER PATIENTS RECEIVING CHEMOTHERAPY. Cheryl A. Bean, RN, DSN, School of Nursing, Univ. of Ala., Birmingham, AL 35294.

A descriptive exploratory study was conducted with a sample of 30 subjects to determine the needs of adults newly diagnosed with cancer and adults with recurrent disease undergoing chemotherapy. The methodology was developed from Roy's (1984) conceptualization of the assessment phase of the nursing process. Data were collected with a semi-structured interview, and subjects' needs were content analyzed using Roy's four modes of adaptation. The highest frequency of needs for adults newly diagnosed with cancer related to self-concept, while interdependence needs were reported most frequently by adults with recurrent disease. Physiological and role function needs were third and fourth in frequency for both groups, respectively. There was a significant difference in the frequency of interdependence needs between the two groups. The strongest relationship was for interdependence needs with the number of disease recurrences. Thus, in response to the repeated assault by cancer or its treatment with chemotherapy, adults with recurrent disease experienced a greater number of needs in all four adaptive modes and particularly needs related to receiving love and caring support from others. The findings highlighted the need for expansion and elaboration of the oncology nurse's role, particularly in the psychosocial domain of adaptation to the cancer experience. Without an accurate and systematic assessment and validation of needs, including spiritual and sexual needs, serious problems can result due to disparate perceptions and affect the physical and psychosocial resources essential for positive adaptation to the cancer process and its treatment requirements.

EVALUATION OF FACTORS INVOLVED IN FALLING EPISODES BY PATIENTS IN DIFFERENT HOSPITALS. Walter J. Jones and James A. Johnson, Health Services and Public Administration, Memphis State University, Memphis, TN 38152. Robert E. Pieroni, Department of Internal Medicine, Univ. of Ala., Tuscaloosa, AL 35487.

Incident reports at two different hospitals (one a mental health facility, the other a large urban general hospital) were examined to evaluate the determinants of patient falling episodes. A total of 338 falling incidents was examined. It was found that the variable of patient age correlates strongly and positively with propensity to suffer falls, particularly with patients over 60 years of age. In addition, medications (particularly multiple medications) were strongly linked to falls: 52.9% of patients suffering falls were under medication, primarily involving drugs from the anti-infective, CNS and electrolytic categories. Falls were more likely to take place during the morning hours. About one-third of the falls were deemed to be serious enough to merit a follow-up investigation. The development of "risk profiles" for patient falls will be useful for risk management at health care facilities.

DIFFERING ATTITUDES TOWARDS EUTHANASIA IN THE UNITED STATES AND THE NETHERLANDS. D. M. Pieroni, B. M. Hinton and R. E. Pieroni, Dept. of Internal Medicine, Univ. of Ala., Tuscaloosa, AL 35487.

We have reviewed recent developments concerning the view of mercy killing in two countries: the Netherlands and the United States. In the U.S. there are counterparts of Dutch euthanasia societies: the American Society for the Right to Die, which seeks reform legislatively, and the American Hemlock Society, which assists terminal patients in dying. The majority of Dutch citizens feel that mercy killing by a physician is appropriate should a terminal patient request euthanasia. Surveys also indicate that the majority of Dutch physicians have, on occasion, actually practiced mercy killing. In the U.S. an effort to legalize active euthanasia is currently gaining support in California. However, a recent poll of U.S. primary care physicians indicated that slightly over 50% are against euthanasia under any circumstances, and about 90% had never participated in mercy killing. The recent descriptions of a purported act of euthanasia by a U.S. physician ("It's Over, Debbie," JAMA 259:272, 1988) resulted in widespread publicity and debate. We shall describe this case, as well as the evolution of Dutch and U.S. attitudes concerning euthanasia. Crucial caveats - moral, medical, and legal - that should be considered in any discussion of mercy killing will be underscored.

CURRENT ISSUES FACING ALZHEIMER'S DISEASE CARETAKERS. Susan F. C. Ramey, Dept. of Political Science, Univ. of Ala., Tuscaloosa, AL 35487 and Fayette-Lamar Association for Retarded Citizens, Fayette, AL 35555. Robert E. Pieroni and Lorin A. Baumhover, College of Community Health Sciences, Univ. of Ala., Tuscaloosa, AL 35487.

Alzheimer's disease, one of the nation's number one killers of older citizens, is not only robbing the elderly of their health and happiness, but also of their life savings. Alzheimer's disease is now not only a medical problem, but a social issue as well. For the past several years, some legislators have been attempting to provide some assistance to the victims and their families. Until recently these proposals have been futile efforts. Advanced efforts to educate the general public, and an increased degree of citizen awareness have proven to now "harbor some light at the end of the tunnel." Legislative murmurs seem to nearly guarantee some aid prior to the end of fiscal year 1988. Although the current proposals in no way provide the assistance the victims of this dreaded "double-killer" long for, these bills are looked upon as "a foot in the door." As the debates continue, the future law promises to be a compromise between the Senate and House bills. An examination of these bills reveals the benefits and deficits in aiding the victims of Alzheimer's disease, both patient and family.

CHARACTERISTICS OF THE FALL-PRONE PATIENT. Arounia P. Frederick, University of Alabama at Birmingham.

The overall frequency of falls in the clinical setting together with professional, moral, and legal accountability for patient safety dictates the need for aggressive fall prevention programs. The ability to recognize fall-prone patients is essential to the success of fall prevention programs. In order to determine the characteristics of the fall-prone patient, 22 patient falls were evaluated in terms of the intrapersonal, extrapersonal, and interpersonal stressors inherent in the fall event. Data were generated from incident reports and patient fall questionnaires completed on each of the subjects who sustained falls during the 3-month study period. Structured on the basis of Neuman's theoretical framework, the patient fall questionnaire is a composite of factors identified in the literature as contributing to falls. Findings suggested that subjects who fell were primarily elderly (77.3%), ambulatory (54.5%), and alert and oriented prior to falls. The majority of subjects (68.2%) had diseases of the vascular system. Altered mobility (54.5%) and impaired vision (54.5%) were commonly observed intrapersonal stressors. Medications (68.2%) represented the most frequent extrapersonal stressor, while staff-patient ratios accounted for the most common interpersonal stressor. Further, it was concluded that some factors commonly associated with falls may not contribute to the fall event. Further research was recommended. The sample for the study was derived from the predominately male population of general medical-surgical in-patients of a Veterans Administration medical center in Alabama.

ACUTE MESENTERIC ISCHEMIA IN THE ELDERLY. R. E. Pieroni, Dept. of Internal Medicine, College of Community Health Sciences, Univ. of Ala., Tuscaloosa, AL 35487.

For a variety of reasons older patients can sustain catastrophic medical problems with minimal signs or symptoms. Recently, a 69 year old female with a leg injury secondary to a fall was hospitalized with severe venous thrombosis and protracted fever. She was anticoagulated and placed on antibiotics. Her abdomen was soft with intermittent bowel sounds. Minimal abdominal tenderness was elicited. Because of multiple severe medical problems she soon expired. On autopsy, extensive acute ischemic colitis from the midtransverse colon to the rectum was noted. Additionally, there was complete occlusion of the inferior mesenteric artery at its origin from the aorta by atheroma. This case is presented to underscore the fact that diagnosis of bowel infarction in older patients is often difficult because of frequent lack of the classical symptomatology usually found in younger patients. We shall present manifestations of, and conditions associated with, mesenteric ischemia, and emphasize the need for a high index of suspicion in diagnosing this insidious disorder, especially in the aged.

RECOGNITION OF PSYCHIATRIC SYMPTOMS AMONG NAVAJO. Harry Goldwasser, College of Community Health Sciences, Univ. of Ala., Tuscaloosa, AL 35487.

American Indians and Alaska Natives have long been ignored in regard to their mental health needs. Current treatment facilities have only a vague notion of the cultural fabric which determines the recognition and reasonable treatment of mental disorders. Few constructive studies have provided validity to specific diagnostic instruments among Native Americans. Utilizing the General Health Questionnaire (GHQ) in a general medicine clinic, a trial was implemented to see if such a questionnaire could be successful in making primary care physicians stop and consider significant psychiatric problems in the Navajo of Chinle. It was found that such a screen could be worthwhile in alerting physicians to suicidal patients and predisposing factors in anxious symptoms such as household size, and number of children. Furthermore, relationships between employment status and GHQ scores varied between men and women, as did several specific responses in the GHQ.

OBSTETRIC COMPLICATIONS, BODY IMAGE AND PERCEPTIONS OF THE INTRAPARTAL EXPERIENCE OF OBESE AND NON-OBESE POSTPARTUM WOMEN. Karen H. Morin, University of Alabama School of Nursing, UAB, Birmingham, AL 35294.

Obesity continues to be a major health problem affecting women. The purpose of this descriptive study was to ascertain whether differences existed between obese and non-obese post partum women in relation to obstetric complications, body image and perceptions of labor. Sample (N=57) criteria included gestational age between 37 to 42 weeks, vaginal delivery of a normal newborn, maternal age between 18 and 40 years, with no uncorrected perceptual impairment. Data were collected in a large teaching hospital in the Southeast U.S. Instruments included Harpenden skinfold calipers, the Attitude to Body Image Scale (ABIS), the Perception of Birth Inventory (POB), a topographic device of concentric circles and a demographic data form. Multiple regression was used to analyze the data. Although only 7 subjects experienced pregnancy-induced hypertension obesity was found to be a significant predictor of that complication ( $p=.03$ ). Obese women viewed their bodies more negatively ( $p=.03$ ) and as larger ( $p=.01$ ) than non-obese women. There were no differences in perceptions of the intrapartum experience between groups ( $p=.24$ ). Conclusions for this sample were that as obesity measurements increased, the likelihood of pregnancy-induced hypertension increased, and body image became more negative. Perceptions of the intrapartum experience were not altered by obesity. Implications included the initiation, in the postpartum period, of such health behaviors as weight control and exercise and the identification of measures that would foster a more positive attitude toward the obese woman's own body.

COMPARISON OF THE QUALITY OF LIFE OF PATIENTS  
WITH RATE RESPONSIVE AND DUAL CHAMBER PACEMAKERS

Rosemary S. Bubien, M.S.N., Donna R. Packa, D.S.N., G. Neal Kay,  
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The purpose of this study was to compare the quality of life of patients following implantation of rate responsive VVI (RR-VVI) and DDD pacemakers. The physical dimension of McMaster Health Index (MHIQ), Psychological General Well Being Index (PGWB), and a measure of patient acceptance of the pacing system (PACSCORE), were determined by self-administered questionnaire mailed to 31 consecutive patients 1-6 months following pacemaker implantation. Seventy four percent of patients responded. The responses of 13 patients with RR-VVI and 10 patients with DDD pacemakers were compared using the Wilcoxon Rank-Sum test and are shown in the table below.

	MHIQ	p	PGWB	p	PACSCORE	p
VVI-RR	0.77	1.0	82.54	0.352	25.69	0.9
DDD	0.75		74.30		25.10	

The MHIQ and PGWB scores correlated strongly with the patients rating of their overall physical function ( $r=0.55$ ,  $0.70$ ), level of health ( $r=0.86$ ,  $0.63$ ), and life satisfaction ( $r=0.61$ ,  $0.74$ ). These data indicate no difference in the quality of life of patients with VVI-RR and DDD pacemakers, with both groups experiencing a moderately high level of physical and psychological well-being.

VARIATIONS IN SERUM TRANSFERRIN AND IMMUNOGLOBULIN LEVELS WITH AGE. K. S. Yackzan and B. R. Boshell, Diabetes Research and Training Center, University of Alabama at Birmingham, Birmingham, AL 35294 U.S.A.

The serum concentrations of four plasma proteins, transferrin (Tf), immunoglobulin G (IgG), immunoglobulin A (IgA), and immunoglobulin M (IgM) were measured in 158 subjects of various ages. Regression analysis was performed on the results to determine if age was related to the protein levels. It was found that Tf and IgM serum concentrations decreased with increased age ( $P<.001$  and  $P<.001$  respectively). IgA levels increased with increased age. The rationale for these differences are discussed.

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INHIBITION OF CELLULAR PROLIFERATION AND THE OCCURRENCE OF ABERRANT MITOSES IN METHYL ACETIMIDATE-TREATED LYMPHOCYTES. Garland M. Brooks and Velma B. Richardson, Tuskegee University, AL 36830 and L. Gayle Littlefield and Shirley P. Colyer, Oak Ridge Associated Universities, Oak Ridge, TN 37831.

The cytogenetic effects of methyl acetimidate (MAI), a lysine-specific protein crosslinking agent, were investigated using short-term human peripheral lymphocyte cultures. Lymphocytes were treated either prior to phytohemmagglutinin (PHA) exposure or 2-3 days following mitogenic stimulation and assessed for changes in cell viability and proliferation kinetics. Synchronized  $G_0$  cultures exposed to 2 to 400 mM MAI showed complete loss of viability at concentrations that exceeded the highest suggested therapeutic level (10 mM). While morphological evidence of "blastic" transformation was observed at concentrations below 5 mM, complete inhibition of cell division occurred in cultures exposed to 4-5 mM. In contrast, cultures exposed to 4 or 5 mM MAI during  $G_0$  showed only moderate increases in SCEs.

Proliferating cells exposed to less than 10 mM MAI during the late  $S-G_2$  stage of the cell cycle and harvested at the first metaphase following treatment exhibited profound mitotic delay, impaired prophase-metaphase transitions and abnormal mitotic configurations. These findings demonstrate that protein-specific crosslinking agents may induce a wide spectrum of adverse cytogenetic outcomes in cycling and noncycling lymphocytes.  
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THE RELATIONSHIP BETWEEN ANAEROBIC THRESHOLD AND DEFLECTION IN HEART RATE DURING ARM CRANK WORK WITH INCREASING INCREMENTAL VELOCITY. Robert Sumsion, Kennon T. Francis, Division of Physical Therapy, UAB, SHRP Bldg., Birmingham, Alabama 35294.

It was recently shown by F. Conconi et. al. that during incremental work in which velocity was increased, that anaerobic threshold corresponded significantly with a deflection in heart rate. His studies involved well-trained athletes most of whom participated in lower extremity activities. The purpose of this study was to determine whether anaerobic threshold could be determined in a similar manner in non-trained individuals during arm crank work which was incremented by increasing velocity. Ten healthy males (mean age  $25 \pm 8$  and mean weight  $171 \pm 6.0$ ) cranked a modified cycle ergometer until exhaustion. Throughout the exercise bout, resistance was increased by 7.0 watts every 30 seconds, at the end of which heart rate and expiratory gases were measured. Heart rate was shown to increase linearly throughout the tests with a point of deflection occurring only infrequently at 95% and above the maximum heart rates. The anaerobic threshold, as determined using gas ratios, ranged from 11.9 - 30.8 ml/kg/min and occurred at 58.0 - 90% of the maximum heart rates. The results indicate that in non-trained individuals there is no relationship between anaerobic threshold and deflection in heart rate response with arm crank work.



NEUROLEPTIC MALIGNANT SYNDROME: AN OVERVIEW IN WEST ALABAMA.  
Harry D. Goldwasser, Nikki Spears and James Hooper, College of  
 Community Health Sciences, Univ. of Ala., Tuscaloosa, AL 35487.

Neuroleptic Malignant Syndrome (NMS) is a complex and life-threatening reaction to neuroleptic medication, thought to occur in about 1% of those receiving the drugs. The syndrome is characterized by a range of symptoms; previous authors herald the features of autonomic instability and rigidity to define the disorder. Furthermore, little attention has been given to the dilemma of retreatment of a previous NMS patient. We present several patients whose NMS was first seen, but not necessarily diagnosed, by non-psychiatric physicians and psychiatrists. Also, we believe elevated CPK levels to be of equal significance to other signs in the diagnosis of NMS. Finally, it appears that concomittant use of bromocriptine and neuroleptics is successful in treating psychosis in a previous NMS patient.

TICK-BORNE BORRELIOISIS (LYME DISEASE) IN ALABAMA: HUMAN CLINICAL CASES.  
C. Steven Murphree and Gary R. Mullen, Dept. of Entomology, Auburn  
 Univ., Auburn, AL 36849-5413.

Lyme disease, first recognized in the U.S. in 1975, has now been reported from 34 states and has become the leading tick-borne disease affecting man. Six human cases of Lyme disease have been documented in Alabama based on positive serological tests using an enzyme-linked immunosorbent assay (ELISA) for the spirochaetal agent Borrelia burgdorferi. The first case occurred in April, 1986 involving a 42-yr-old woman exposed to ticks while hiking with her family at the Choccolocca Wildlife Management Area, Cleburne County; she developed the characteristic skin lesion, erythema chronicum migrans (ECM), fever, and complained of feeling "flushed and tense." In 1987, a 29-yr-old woman living in Tallapoosa County did not develop the ECM lesion but experienced stiffness in the forearms. The remaining four cases occurred among a family of six at Auburn, Lee County. The 35-yr-old mother, her 8-yr-old son and 15-mo-old son experienced few symptoms while her 5-yr-old son developed severe arthritis in one knee but no ECM lesion. Four other suspect cases with symptoms consistent with Lyme disease but negative ELISA tests have been identified in Tallapoosa County. A 10-yr-old boy from New York visiting relatives in Tallapoosa County was diagnosed positive for Lyme disease but is believed to have been infected prior to arriving in Alabama. The primary tick vector of Lyme disease in the eastern U.S. is Ixodes dammini which is not known to occur in Alabama. Efforts to determine the tick species responsible for transmission of B. burgdorferi in the state have been unsuccessful. Attention is being focused on the black-legged deer tick, Ixodes scapularis, as the most likely vector.

PUBLIC HEALTH PROGRAM FOR TB IN ALABAMA (ITS BIRTH AND EVOLUTION).

David Bahar, M.D., Professor of Medicine, Capstone college of Community Health Sciences, Univ. of Ala., University, AL. 33555. Area Coordinator for TB Control.

In the early 1960's, the public health clinics for TB were limited to large urban areas, with very poor results in new case-findings or case-holdings. More emphasis was put on treating patients in TB hospitals (total number of beds: 1132). Despite high numbers of non-compliant patients, the post-discharge follow-up was deficient. As a result Alabama was one of the states with the highest mortality and morbidity rates of TB in the country. Since the mid-1970's the situation has markedly improved with a new administrative reorganization, by elimination of non-productive activities from the overall program, by treating patients on an out-patient basis whenever possible, by dramatically reducing the length of stay of hospitalized patients and establishing an aggressive follow-up program in the public health departments throughout Alabama. As a result all TB hospitals have been closed, the number of beds have been reduced to 44 in six Contract hospitals. The performance standards in the number of cases started on chemoprophylaxis with INH, the number of close contacts completing preventive treatment, the number of contacts examined of each source case, the rates of sputum conversions within three and six months markedly improved and exceeded the minimum numbers recommended by the public health service. All these results have been achieved with significant savings in tax dollars. The TB Control Program today spends less state money despite the inflation since the 1960's and complete cut-off of federal subsidies. The Alabama TB Control Program has been recognized as one of the best in the nation.

TRACING A TYPHOID CARRIER. Robert E. Pieroni and Susan Watkins, Dept. of Internal Medicine, Univ. of Ala. and Dept. of Public Health, Tuscaloosa, AL 35487.

We shall describe the case of a 40 year old male, initially comatose, who exhibited multiple life-threatening medical problems. These included acute lead intoxication from moonshine ingestion, as well as pancreatic, hepatic, renal, hematologic, and endocrinologic abnormalities. In addition to the above, the patient was found to have typhoid fever. Fortunately, we were able to successfully treat the patient, and, with the assistance of the Department of Public Health, identify the typhoid carrier. The latter, an elderly female proprietor of a "shot house," was also successfully treated. We shall describe in detail methods used to treat patients with typhoid fever, as well as typhoid carriers. The use of chelation therapy for severe lead intoxication will also be discussed.

MEDICARE/MEDICAID FRAUD AND ABUSE: SOME UNEXPECTED RESULTS.

C. George Tulli, Jr., Capstone Medical Center, College of Community Health Sciences, University of Alabama, Tuscaloosa, Alabama, 35401

Medical practitioners have argued that they simply cannot keep up with the changing regulatory requirements of the Medicare and Medicaid programs. Medical practice managers, i.e. practice administrators, business managers or clinic supervisors have echoed these concerns. This view could explain, at least in part, the substantial increase in prosecutions and administrative sanctions of practitioners that were authorized and fostered by the enactment of the Medicare-Medicaid Anti Fraud and Abuse Amendments of 1977 and the Civil Money Penalties Law of 1981. Using a telephone survey instrument, Alabama medical practice managers were contacted to determine their knowledge of fraud and abuse offenses in Medicare regulations. The results suggest, however, that, as a group, the medical practice managers are, in fact, quite knowledgeable about the regulatory requirements of fraud and abuse in the Medicare program.

A COMPARISON OF THE EFFECTS OF THE NEEDLE GAUGE ON HEMOLYSIS IN TRANSFUSION OF ERYTHROCYTES. Gaynell Reeves, School of Nursing, University of Alabama at Birmingham, Birmingham, AL 35294.

Sources vary in the recommended needle gauge to be used for parental infusion of red blood cells (RBC). Since the RBC is very fragile, it is conceivable that the cell is capable of hemolysis during a transfusion process. No research data could be identified which specifically analyzed the effects the needle gauge might have on hemolysis. Specimens for this study were collected from 20 unused units of packed red blood cells, which were 6-day stored cells or less. The needle gauges utilized in the collection process included 16-, 18-, 20-, and 22-gauge needles. A hemoglobin count was computed on the collected specimen to determine RBC hemolysis. The simple analysis of variance statistical test, using the F distribution at the .05 level of significance, was computed on the collected data. No significant effect of the needle gauge on hemolysis was established in this study. However, a trend was established in the hemoglobin mean data analysis. This trend indicated less hemolysis of the RBC occurred with the use of a larger needle gauge. To maintain integrity of the RBC and the client's state of health, the findings of this study support the idea of utilizing a larger needle gauge for blood transfusions until additional studies are conducted.

ANXIETY AND PHYSIOLOGICAL PARAMETERS UTILIZED WHEN WEANING PATIENTS FROM MECHANICAL VENTILATION IN THE MICU. Brenda S. Walker. Graduate Student, Univ. of Ala. at B'ham., School of Nursing.

Seventeen mechanically ventilated patients with a wide variety of medical problems agreed to participate in this study to ascertain the relationship between anxiety and some of the physiological parameters utilized when weaning patients from mechanical ventilation in the medical intensive care unit (MICU). The research design for this study was a descriptive survey. The review of research in total, revealed a noticeable lack of any studies related to anxiety and the process of weaning the adult patient from mechanical ventilation. The parameters under investigation included: non-verbal anxiety; negative inspiratory force (NIF); tidal volume ( $V_T$ ); respiratory rate (RR); minute ventilation (MV); and heart rate (HR). The non-verbal assessment of anxiety was assessed utilizing a checklist developed by Latham (1985). The tool was used for responsive adult patients in the MICU. Data were collected three times per week on each patient once weaning had been ordered to begin by the patient's physician. Data were collected until weaning was complete or was ordered to be discontinued by the physician. The 10 male and 7 female patients varied in age from 27 years to 76 years with a mean of 56.88. Eleven of the 17 patients were successfully weaned during the course of the study. Data analysis using pearson correlation revealed no statistically significant relations between the non-verbal assessment of anxiety scores (NAAS) and the physiological parameters of NIF,  $V_T$ , RR, MV, and HR. The recommendation is made that this study be replicated utilizing a more sensitive measurement for anxiety and a larger sample size.

DROPPING THE BALL - SOME NOT-SO-SURPRISING RESULTS TO A SURVEY OF ALABAMA PHYSICIANS CONCERNING ELDER ABUSE. Carolyn Lea Clark-Daniels, Center for the Study of Aging, College of Community Health Sciences, University of Alabama, Tuscaloosa, AL 35487.

Physicians in Alabama do not understand the Protective Service Act of 1976 which was meant to protect adults in need of such protection. A survey funded by a Biomedical Research Grant and the College of Community Health Sciences, University of Alabama, found this statement to be true. In particular, the survey concerned what physicians knew about handling cases of elder abuse. Physicians responses to the survey showed that they were confused about the handling of elder abuse cases, but they wanted to know what guidelines were available for the future. While most physicians felt that they had a legal responsibility to report cases of elder abuse, half were unsure of Alabama's standard procedures for dealing with abuse and three-fourths were unsure how to report abuse.

BIOCHEMICAL AND PHARMACOLOGICAL STUDIES WITH N-ARYLSULFONYLGLYCINE ALDOSE REDUCTASE INHIBITORS. Charles A. Mayfield and Jack DeRuiter, Department of Pharmacal Sciences, School of Pharmacy, Auburn University, AL 36849.

A number of N-arylsulfonylamino acids were studied as inhibitors of the enzyme aldose reductase and potential therapeutic agents for the prevention of chronic diabetic pathologies (retinopathy, cataracts, neuropathies, nephropathies). Generally, in the in vitro enzyme assay arylsulfonylglycines display superior inhibitory activity to the corresponding alanines and prolines. Also, the most potent arylsulfonylglycines are those which possess a naphthalene or 4-benzoylamino benzene aryl substituent. Modification of the arylsulfonylglycine structure by N-methyl or N-phenyl substitution usually results in enhanced in vitro inhibitory activity. Furthermore, alpha-phenyl substitution results in both increased potency and stereospecificity. For example, the S-N-arylsulfonyl- $\alpha$ -phenylglycines are 2 to 10 times more active than the corresponding glycines, and 5 to 100 times more potent than their corresponding R-enantiomers. Kinetic analyses with the N-arylsulfonylamino acids revealed that the profile of inhibition produced by these compounds is concentration dependent; they produce uncompetitive inhibition with respect to both substrate and cofactor at lower concentrations and non-competitive inhibition at higher concentrations. Preliminary enzyme specificity studies have demonstrated that these novel aldose reductase inhibitors do not significantly inhibit other oxidoreductases and are selective in action. The biochemical and pharmacological properties of these novel aldose reductase inhibitors will be discussed in detail.

QUININE-INDUCED THROMBOCYTOPENIA AND NEUTROPENIA: A CASE REPORT. S. M. Brasfield, W. A. Curry, G. D. Heggie and R. E. Pieroni, Dept. of Internal Medicine, Univ. of Ala., Tuscaloosa, AL 35487.

This is a case report of a 57 year old female who experienced several hematologic side-effects of quinine therapy, including thrombocytopenia and neutropenia. Quinine, an alkaloid derivative of cinchona bark, has been used extensively in the treatment of malarial infections, and is frequently used in patients with nocturnal recumbency leg muscle cramps. Thrombocytopenia is a relatively common side-effect, occurring in about one in a thousand patients exposed to pharmacologic doses of quinidine or quinine. Neutropenia, acute hemolysis, and hypoprothrombinemia are also reported hematological side-effects, although much less common than thrombocytopenia. Proposed mechanisms of action, and possible therapeutic modalities will be discussed, as will the benign clinical course experienced by the female in this report, despite her multiple prominent initial hematological abnormalities.

INTERRELATIONSHIP OF INFORMATION, ANXIETY, NETWORK, AND MILK PRODUCTION DURING EARLY BREASTFEEDING AND EFFECT ON CONTINUATION. Ellen B. Buckner, University of Alabama School of Nursing, The University of Alabama at Birmingham, Birmingham, Alabama 35294.

For the mother choosing to breastfeed her newborn, the period of early breastfeeding is marked by rapid change in multiple domains. This research utilized four developmental domains - biological, cognitive, affective, and social - to describe early breastfeeding and subsequent continuation. Subjects were 60 primiparous mothers completing an uncomplicated term gestation with a normal vaginal delivery and infant birthweight greater than 5.5 lbs. Initial data collection took place 48 to 72 hours after delivery. Subjects completed three questionnaires, the Breastfeeding Information Test, the Spielberger State Anxiety Inventory specific to feelings about breastfeeding, and the Total Network Subscale of the Norbeck Social Support Questionnaire specific to breastfeeding support. Milk production was measured by test weighing of the infant before and after the morning feeding. Continuation at 2 and 4 weeks postpartum was determined through a follow-up phone interview. A significant discriminant function was found at 4 weeks,  $\chi^2 = 15.23$ ,  $p \leq .004$ . This function was able to successfully classify cases with a 73% accuracy. Primary variables distinguishing between groups were information and network. Recommendations are: (a) support for breastfeeding should be directed toward assistance during the early period, (b) nursing education should continue to include content on breastfeeding with particular emphasis on assessments in all domains, (c) further studies should be conducted to confirm these findings.

EVALUATION OF FACTORS INVOLVED IN DRUG ERRORS AT DIFFERENT HOSPITALS. Walter J. Jones and James A. Johnson, Health Services and Public Administration, Memphis State University, Memphis, TN 38152. Robert E. Pieroni, Dept. of Internal Medicine, Univ. of Ala., Tuscaloosa, AL 35487.

Incident reports at two different hospitals (one a mental health facility, the other a large urban general hospital) were examined to evaluate the determinants of drug errors. A total of 397 drug errors was analyzed. It was found that older patients (over 60 years of age) were significantly overrepresented in drug errors, being involved in 55.1% of the cases. Patients receiving multiple medications were also at risk of drug errors, constituting 52.7% of the error total. Drugs from the anti-infective, CNS and electrolytic groups were collectively involved in 56.7% of medication incidents. The most common type of incident involved the omission of medication. We found that 14.5% of drug errors involved the administration of an incorrect drug. The development of patient "risk profiles" for drug errors will help health care personnel maximize their ability to carry out effective risk management at their facilities.

EXERCISE PRESCRIPTION FOR CARDIORESPIRATORY ENDURANCE, WEIGHT REDUCTION, STRENGTH, AND FLEXIBILITY. Maridy M. Bronstein, Dept. of Health, Physical Education, and Recreation, Univ. of Ala., Tuscaloosa, AL 35487.

Improvement in cardiorespiratory fitness is related to initial status of health and fitness, mode of exercise (running, swimming, cycling), regularity of exercise, and age. These factors, as well as individual interests and motivation, should be considered when designing an exercise prescription to meet the needs and abilities of each person involved in a training program. A safe and effective exercise program should designate the type of physical activity, its intensity, duration and frequency, and the associated rate of progression. The above components are important in the development of an exercise program and are applicable to all persons regardless of age, functional capacity, or the presence or absence of disease. Exercise prescription is based upon an individual's needs, interests, and physical health status. Because people vary widely in their health and fitness status, a clear understanding of each person's capabilities is necessary to safely and properly prescribe exercise. The maximal safe and effective exercise prescription for any individual is best determined from a direct objective measurement of physical fitness, such as heart rate, arterial blood pressure, ECG, and functional capacity during an exercise test. A comprehensive approach can then be designed to enhance the health related components of physical fitness, i.e., cardiorespiratory endurance, body composition, flexibility, and muscular strength and endurance.

THE RELATIONSHIP BETWEEN ANAEROBIC THRESHOLD AND DEFLECTION IN HEART RATE DURING ARM CRANK WORK WITH INCREASING INCREMENTAL LOAD. Douglas Hansen, Kennon T. Francis, Division of Physical Therapy, UAB, SHRP Bldg., Birmingham, Alabama 35294.

It was recently shown by F. Conconi et. al. that during incremental work in which velocity was increased, that anaerobic threshold corresponded significantly with a deflection in heart rate. His studies involved well-trained athletes most of whom participated in lower extremity activities. The purpose of this study was to determine whether anaerobic threshold could be determined in a similar manner in non-trained individuals during arm crank work which was incremented by increasing load. Ten healthy males (mean age  $25 \pm 8$  and mean weight  $171 \pm 6.0$ ) cranked a modified cycle ergometer until exhaustion. Throughout the exercise bout, resistance was increased by 6.25 watts every 30 seconds, at the end of which heart rate and expiratory gases were measured. Heart rate was shown to increase linearly throughout the tests with a point of deflection occurring only infrequently at 95% and above the maximum heart rates. The anaerobic threshold, as determined using gas ratios, ranged from 10.5 - 30.8 ml/kg/min and occurred at 55.4 - 84.3% of the maximum heart rates. The results indicate that in non-trained individuals there is no relationship between anaerobic threshold and deflection in heart rate with arm crank work.

EMBRYOTOXIC EFFECTS OF SERUM-SUPPLEMENTED CULTURE MEDIA: A COMPARISON OF BWB-BSA AND HAM'S F10 SUPPLEMENTED WITH HUMAN SERUM. Joe R. Warren and Wayne H. Finley, Laboratory of Medical Genetics, Charles P. Dagg, Department of Biology, and Michael P. Steinkampf, Department of Obstetrics and Gynecology, University of Alabama in Birmingham, Birmingham, AL 35294.

The standard procedure for testing for possible embryotoxicity of patient serum in UAB's in vitro fertilization program is a 2-cell mouse embryo assay. In this assay, superovulated mouse embryos are collected at the 2-cell stage and incubated in Ham's F10 media, normally supplemented with patient serum, or BWB-BSA (Biggers, Whitten, and Whittingham supplemented with bovine serum albumin), a control medium designed to support embryo growth. A direct comparison of embryo survival rates in serum-supplemented Ham's F10 and BWB-BSA indicates that the Ham's F10 does not support survival as well as BWB-BSA due, in part, to the embryotoxic effects of the sera from certain patients. Furthermore, while Ham's F10 can support embryo growth and survival without the addition of serum, it is still less effective as an embryo growth medium than BWB-BSA.

NUTRITIONAL STATUS OF HIGHLY TRAINED FEMALE ATHLETES. Beverly J. Warren, G. Dennis Wilson, Daniel L. Blessing, Dept. of Health and Human Performance, Auburn University, Auburn, AL, 36830.

Increasing attention has been given to the nutritional status of the highly trained athlete with particular focus on those sports where body weight is critical to performance. It was the purpose of this study to assess the nutritional status, body composition, and attitudes toward eating of female gymnasts (n=15) and cross country runners (n=12). Each subject was hydrostatically weighed to predict percent body fat. Additional data were collected utilizing a three day dietary recall and two surveys assessing attitudes toward eating: the Eating Disorder Inventory (EDI) and the Eating Attitudes Test (EAT). Results indicated that although all athletes were in the normal range for percent body fat, over 70% reported kilocalorie intakes below the RDA for females of college age. Results of the EDI and EAT inventories suggest that the gymnasts and cross country runners did not differ from the scores of normal college age females on either inventory although the gymnasts evidenced greater drive for thinness ( $F=8.97$ ,  $p<.05$ ), greater body dissatisfaction ( $F=5.88$ ,  $p<.05$ ), and greater tendencies toward anorexia ( $F=5.04$ ,  $p<.05$ ) than did cross country runners). In conclusion, the diets of the gymnasts and cross country runners were low in total energy consumption and were at suboptimal levels in several essential micronutrients (pyridoxine, cobalamin, vitamin A, vitamin C, calcium, magnesium, zinc, and iron). However, with no alarming values reported for body fat percent or eating attitudes scores, it appears that simple nutritional counseling would alleviate the problem areas.



ALDOSE REDUCTASE AND CHRONIC DIABETIC PATHOLOGIES. Jack DeRuiter, Department of Pharmacal Sciences, School of Pharmacy, Auburn University, AL 36849.

Diabetes mellitus is a disease which affects more than 5 million people in the US and more than 200,000 people in Alabama. This disorder is characterized by several acute symptoms, such as hyperglycemia, as well as a number of chronic complications including neuropathy, nephropathy, retinopathy, cataracts and cardiovascular disease. There is a growing body of evidence to suggest that these chronic pathologies may result from the formation and accumulation of the polyol sorbitol in nerve, renal and ocular tissues. Sorbitol is formed in these tissues from glucose in a reduction reaction mediated by the enzyme aldose reductase. Therefore one approach currently explored to prevent or delay the onset of chronic diabetic pathologies involves the development aldose reductase inhibitors (ARIs). To date a variety of compounds have been found to inhibit AR in vitro, and several of these agents have proven effective in preventing neuropathies, nephropathies and cataract development in diabetic animals. Furthermore, based on their efficacy in animal models, a number of ARIs including sorbinil, tolrestat, ponalrestat and epalrestat have been approved for clinical trials in human diabetics. Preliminary results from these trials suggest that ARIs may improve symptoms associated with neuropathies and other chronic complications.

THE MORPHOGENESIS OF RETINOIC ACID-INDUCED POLYDACTYLY IN MICE, S. Bynum and C. P. Dagg, Dept. of Biology, University of Alabama at Birmingham, Birmingham, Alabama 35294.

An ICR mouse strain which exhibited a low frequency of spontaneous postaxial polydactyly in the forepaws developed a high percentage of individuals with this digital defect when the mothers were treated with 100 mg/kg of retinoic acid on day 10 of gestation. A toluidine-safranin stain for cell death (Martin-Partido et. al., 1986) showed signs of mesodermal cytotoxicity in the forepaw that began 12 hours after treatment and peaked 12 hours later. On day 11.5, Nile blue staining detected a physiologically normal necrotic area known as the fpp (foyer preaxial primaire). The treated group exhibited an increase of necrotic cells in the fpp on day 11.5 as well as in the marginal necrotic areas which occurred on day 12. Preliminary evidence indicated the postaxial ectoderm was still hyperplastic in the treated group on day 12 while the ectoderm of the control group had regressed. Measurement of the supernumerary digit size on day 14 indicated the treatment resulted in a significantly larger tissue mass with relatively reduced necrosis. It was concluded that both the early and delayed cytotoxicity combined with a prolonged survival of the post-axial ectoderm led to the increased frequency of polydactyly in retinoic acid-treated fetuses.

OCCULT ARSENIC POISONING. George Miller and Robert E. Pieroni, Dept. of Internal Medicine, Univ. of Ala., Tuscaloosa, AL 35487.

Arsenic was first used as a medication for dermatitis by Greek and Roman physicians. However, it is best known for its reputation as a poison. In the Middle Ages it was an instrument of murder, and, even with modern methods of detection, this element is still used for its potential lethal properties. When used carefully arsenic has beneficial agricultural and industrial applications. However, unintentional poisonings, although infrequent, continue to occur. We shall describe a middle-aged male with multiple severe medical problems for whom we were consulted. After careful questioning a source for accidental arsenic intoxication (a commercial weed-killer) was detected, and the patient was promptly placed on chelation treatment. His severe multi-organ failure improved dramatically, and he has suffered no subsequent untoward effects. Arsenic poisoning, with special emphasis on diagnosis and treatment, will be discussed in detail. The need to recognize potential environmental hazards will be stressed.

FOLK MEDICINE BELIEFS AND ADHERENCE WITH PRESCRIBED MEDICATIONS. Michelle M. Acree and Robert E. Pieroni, College of Community Health Sciences, Univ. of AL, Tuscaloosa, AL 35487.

The presence of folk belief systems poses potential problems for medical practice and may cause persons to defer timely treatment, or to use prescriptions in a manner that is inconsistent with scientific use. Ultimately, this can be detrimental to the health of the patient and to the reputation of modern medicine as an effective body of healing knowledge. Elderly patients, especially Black patients, are thought to produce a variety of folk beliefs, a supposition that has been supported by anecdotal evidence from the literature. In the present study sample, we examined patients who were 60 years or older and were being regularly seen by the participating internist in his practice at Capstone Medical Center. All black patients and over 90% of white patients interviewed had two or more folk beliefs. Educational level of the patient may be a significant determining factor, as those patients interviewed who had Bachelor's degrees did not report the presence of any folk beliefs that interfered with their seeking medical assistance. Patient compliance with prescribed medicine exceeded 90% and patients knew why over 90% of their medications were being prescribed. The conclusion can be drawn that in this population other factors must be responsible for the high level of compliance despite low average formal education, and presence of folk beliefs. These factors may be the high level of patient education practiced by the physician and the staff (all medicines are carefully monitored and explained), or may be due to other practice variables which we are currently examining.

SUPEROVULATION OF CB6F1/J MICE: THE EFFECTS OF PRIOR INJECTIONS AND NORMAL VARIATION. Joe R. Warren and Wayne H. Finley, Laboratory of Medical Genetics, and Charles P. Dagg, Department of Biology, University of Alabama in Birmingham, Birmingham, AL 35294.

In order to obtain large numbers of embryos for embryo growth and survival studies, female mice are superovulated by injections with gonadotrophins to stimulate follicle production and ovulation. This procedure increases the mating rate of the mice as well as the number of embryos produced by each responsive mouse. Moreover, it is particularly convenient since it allows the investigator to control the day of mating. In this study, mice of a particular hybrid strain (CB6F1/J), chosen because of their responsiveness to gonadotrophic stimulation, were superovulated, and the number of embryos obtained was recorded over a two year period. Although superovulated mice are a more consistent source of embryos than naturally mated mice, the numbers obtained from month to month or, sometimes, even week to week can vary widely. Here, the mating rates (rates at which vaginal plugs were observed) ranged from 0 to 100%, averaging approximately 55%, while the average number of embryos obtained per mated mouse ranged from 0.75 to 21.5. In addition, while mice undergoing their first exposure to gonadotrophic stimulation mated over 55% of the time, only about 20% of the previously exposed mice mated after subsequent injections, but those that did produced comparable numbers of embryos, averaging 12.7 embryos per mouse.

Evaluation of a Teen Parent Program Designed to Reduce Child Abuse and Neglect and to Strengthen Families. Elaine Marshall, R.N., M.S.N. and Kathy Powell, R.N., M.S.N., University of Alabama at Birmingham School of Nursing, Birmingham, Alabama.

This research will focus on evaluation of a teen parent program at Children's Aid Society. The program is designed to reduce child abuse and neglect and to strengthen families. A sample group will be selected from Western Health Clinic for comparison. Both groups will be pre and post-tested utilizing these research instruments: Coopersmith's Self Esteem Inventory, Inventory of Parents' Experiences, and the Denver Developmental Screening Test. The variables to be studied are self-esteem, parenting satisfaction, and child development.

A total sample of 60 teen parents will be invited to participate.

Data collection is anticipated to be completed in 6-9 months. Descriptive statistics, univariate analysis of variance, and multivariate analysis of variance will be utilized to analyze data. Pre and post-test scores will be compared for equality.

Recommendations will include sharing of nursing knowledge and expertise in various approaches for improvement in services and continued evaluation.

BALANCE PERFORMANCE AND STEP WIDTH IN NON-INSTITUTIONALIZED ELDERLY WOMEN. Debra K. Heitmann, Marilyn Gossman, Shirley A. Shaddeau, Div. of Physical Therapy, Univ. of Al. at Birmingham, Birmingham, AL 35294. James R. Jackson, Office Educ. Development, School of Medicine, Univ. of Al. at B'ham, Birmingham, AL 35294

The purposes of this study were to compare age, static balance performance, and step width variables between fallers and nonfallers in elderly non-institutionalized women, and determine the relationship between balance performance and the mean and variability of step width. Each subject performed a maximum of three timed trials on the Sharpened Romberg and the one-legged stance tests, with eyes-opened and eyes-closed. The first and best trial scores were used for analysis. Each subject walked on paper walkways making ink prints for step width measurements. The mean and variability in step width were subjected to analysis. One hundred ten women, aged 60 to 89 years, participated. The nonfallers scored significantly higher than the fallers on the best trial of the Sharpened Romberg, eyes-opened condition ( $t = 1.98$ ,  $df = 108$ ,  $p < .05$ ). The mean scores on the first trials were significantly lower than the mean scores on the best trials for each balance test ( $t = -5.76$ ,  $df = 107$ ,  $p < .05$ ). No significant differences between fallers and nonfallers were revealed in age, the mean and variability of step width, the first trials of the balance tests, and the best trials on the other balance tests. No significant relationships existed between balance performance and either mean or variability of step width. The best trial on the Sharpened Romberg, eyes-opened test was the most sensitive of the tests used in this study to determine differences in balance between fallers and nonfallers in elderly non-institutionalized women.

INFANT BIRTHWEIGHT AND LENGTH OF LABOR BETWEEN PRIMIGRAVIDAS WHO EXERCISED DURING PREGNANCY AND THOSE WHO DID NOT EXERCISE. Midge N. Ray, School of Nursing, Univ. of Ala. at Birmingham, Birmingham, AL 35294.

The purpose of this study was to determine if the primigravidas length of first stage of labor and the infant birthweight for women who exercised during pregnancy was different from those primigravidas who did not exercise. After the 34th gestational week, women were asked to fill out a survey regarding their exercise habits during a prenatal office visit. Upon delivery, their length of labor, infant birthweight, and other data were obtained from the labor and delivery record. The number of subjects consisted of 30, 20 of whom exercised and 10 of whom did not exercise.

No significant difference ( $p < .05$ ) was found in the primigravidas' length of labor and infant birthweight between those who exercised during pregnancy and those who did not exercise.

PROPRANOLOL BINDING BY HUMAN ALBUMIN AND  $\alpha_1$ -ACID GLYCOPROTEIN IN THE PRESENCE OF A PERFLUORO-CHEMICAL BLOOD SUBSTITUTE. D.L. Parsons and R.L. Shih, School of Pharmacy, Auburn University, AL 36849.

The binding of propranolol by human albumin (HSA) and  $\alpha_1$ -acid glycoprotein (AGP) was examined in the presence of a perfluorochemical blood substitute. The percent free propranolol at 37°C was determined utilizing a dialysis exchange method. A centrifugation method was used to determine the percent bound propranolol associated with the emulsion droplets in the presence of the proteins. In 4% HSA solutions the percent free propranolol was 51.9% and 53.6% at propranolol concentrations of 100 and 500 ng/ml, respectively. Dilution of the HSA solutions with buffer resulted in an increase in the percent free propranolol. However, dilution of the HSA solutions with the blood substitute resulted in a significant decrease in the percent free propranolol. In solutions containing 4% HSA with 0.067% AGP the percent free propranolol was 22.6% and 23.5% at propranolol concentrations of 100 and 500 ng/ml, respectively, and increased upon protein dilution with buffer. Again, dilution with the blood substitute resulted in a decrease in the percent free propranolol. These results indicate that the affinity and/or capacity of the blood substitute for propranolol is substantial. Further studies demonstrated that propranolol is highly bound by the blood substitute even in the presence of HSA and AGP. For example, in a 50:50 mixture of the blood substitute and the HSA with AGP solution, over 50% of the bound drug is associated with the blood substitute. Thus, administration of this blood substitute may not result in a significant increase in percent free propranolol normally associated with plasma protein dilution.

CLINICAL MEDICAL LIBRARIAN IN MEDICAL TEACHING PROGRAMS. Maridy M. Bronstein and Robert E. Pieroni, Dept. of Internal Medicine, Univ. of Ala., Tuscaloosa, AL 35487.

The rapid proliferation of medical knowledge mandates that physicians and other health care workers do their utmost to update constantly their data bases in order to provide optimal patient care. In 1979 we evaluated the utility of a Clinical Medical Librarian (CML) in helping to fulfill this vital need at Capstone Medical Center. We shall provide data on the utility of CML's in providing timely and appropriate literature searches, and in answering specific queries for members of our medical team - in hospital as well as outpatient settings. The involved medical students, residents, and attending physicians uniformly rated the CML's many services as an exemplary contribution to patient care. We shall review the history of various types of CML programs and delineate the many ways in which a CML can significantly contribute to both medical education and patient care.

## ENGINEERING AND COMPUTER SCIENCE

DENOTATIONAL SEMANTICS-DIRECTED COMPILER GENERATION FOR DATA FLOW MACHINES (DENOTATIONAL DATAFLOW). William S. Chao and Barrett R. Bryant, Department of Computer and Information Sciences, University of Alabama at Birmingham, UAB Station, AL 35294.

The *denotational semantics* approach, also known as the mathematical approach, to formal specification of programming languages contains detailed information for the implementation of those languages. A compiler can be systematically constructed from the formal denotational semantics specification by applying the function of the specification to the source program. This is called the *compile-evaluate* approach for denotational semantics or *compiler generation*. Compiler generation addresses the issue of proving compiler correctness in that the generated compilers will function according to the programming language specifications. Existing denotational semantics implementation systems generate theoretical or mathematical machine code. For execution efficiency, it is better to generate real machine code from the denotational semantics specification of any language. The data flow machine code displays the maximum amount of parallelism of an imperative program. This paper shows how denotational code optimization of imperative programs can be taken much further than present semantics-based methods by unfreezing the store algebra and allowing partial evaluation to proceed on store-based entities. The technique is termed Denotational Data Flow Analysis which has the effect of extracting the essence of imperative programs. The novelty of our system is that the generated compilers not only translate source programs into semantically equivalent object code, but also completely remove the store component of the source program semantics entirely. While our object code can be translated into register machine code, it may also be directly executed on a data flow machine, which results in the imperative programs being executed in parallel wherever possible for improved execution time efficiency.

EFFECT OF COIL REINFORCEMENT ON BOLT PULLOUT IN CONCRETE. James M. Lane, Dept. of Civil Engineering, Univ. of South Alabama, Mobile, AL 36688.

A series of tests was performed to determine the effect of coil reinforcement surrounding a bolt on the ultimate force attained when the bolt was subjected to a tensile load. The bolts were 0.75 inch diameter and were embedded 7.5 inches in concrete. All bolts were normal to the surface of the concrete and were placed at distances of 1.75, 2.25, and 2.75 inches from one edge of the concrete. The steel coil reinforcement had wire diameters of 0.215, and 0.245 inches; overall diameters of 5 and 6 inches; and coil pitches of 1.0 and 1.5 inches. The overall length of the coils was 10 inches. The tests showed no significant increase in ultimate pullout values for bolts surrounded by coils.

COMPUTER SIMULATION OF ADAPTIVE OPEN-LOOP DRUG INFUSION. Dalton S. Nelson and Thomas C. Jannett, Department of Electrical Engineering, The University of Alabama at Birmingham, Birmingham, AL 35294.

An adaptive open-loop drug infusion algorithm was developed to precisely control drug serum concentrations at a desired value. The infusion regimen necessary to rapidly attain and maintain a desired drug serum concentration for a pharmacokinetic model was implemented. The initial estimates of an individual patient's pharmacokinetic parameters used in the infusion regimen were the mean parameters of the patient population. The pharmacokinetic parameters of the individual patient were estimated as measurements of the serum concentration became available. Based on the revised parameter estimates and the measurement, the infusion rate was adjusted by the adaptive algorithm as necessary to achieve and maintain the desired concentration. The validity and overall dynamic behavior of the algorithm was tested in computer simulations programmed in the C language. The system was tested for both one-compartment and two-compartment pharmacokinetic models. The control of drug serum concentrations with adaptation based on measured serum levels was compared to the control achieved using an infusion regimen based on the mean parameters of the patient population without the use of measurements (open-loop control). Better control of drug serum concentrations was achieved in simulations with the adaptive method than with the open-loop method. Further research should be conducted to allow the adaptive algorithm to be implemented and tested in clinical trials.

CMOS SRAM Upset Using Lasers and Flash X-Rays, Wilford D. Raburn  
Department of Electrical Engineering, University of South Alabama  
Mobile, Alabama 36688

One of the major limitations of memory or logic integrated circuits designed to operate in nuclear or space environments is their susceptibility to upset due to ionizing radiation. Circuits so designed must undergo extensive testing. The bulk of this testing is done using high energy flash x-rays or linear accelerators as sources to simulate the environment. Such testing is difficult, expensive, time consuming and must be done at a remote site. This work investigates the use of lasers as a source to simulate high dose rate gamma radiation. In comparison to the flash x-ray or linear accelerator the laser is relatively inexpensive. It is safe to operate and can be located in or near the fabrication line. Laser testing can be done either on packaged parts or at the wafer level. Since there is no permanent damage to the circuit caused by the laser, one hundred percent testing is possible. A part of the experimental work was to obtain upset thresholds as a function of applied voltage on packaged 16K CMOS SRAMS using the laser as a source. The experiment was then repeated on the same parts using the flash x-ray as a source. When corrections were made for metalization and different pulse widths the results using the two sources agreed within experimental error. Data was also taken at the wafer level using the laser as a source with excellent results. Wafer level testing is not practical using other sources. Finally the effectiveness of feedback resistors in preventing upset was demonstrated using the laser.

## Abstracts

THE BELL SOUTH SERVICES ALL-IN-1 MAIL BRIDGE - GATEWAY TO PROFS AND UNIX. John Barrett, Frank de Lathouder, Janice E. Tork, and Angela D. Carman, BellSouth Services, 1876 Data Drive, Room S-306, Birmingham, AL 35244.

The BellSouth Services mail bridge system is a locally developed interface. It connects several thousands of users on different electronic mail systems: DEC ALL-IN-1, IBM PROFS, and three different AT&T UNIX based mail systems. The mail bridge software uses ALL-IN-1's programmable facilities along with several off-the-shelf communications and document translation packages. In addition to basic connectivity, the mail bridge features transparent transmission of revisable documents. The mail bridge currently consists of a single VAX processor which acts as a node in each office mechanization network. Mail addressed to a user located in a different office mechanization environment is routed to the mail bridge. The mail bridge software looks for in-coming mail, repackages it to look like native mail in the receiving system, and sends the message using the recipient's mail facility. The repackaging of a mail message involves two steps. First, we translate the message or document from the sender's word processing format to the recipient's word processing format. Then we build an envelope for the message in the format required by the recipient's mail facility. Thus the BellSouth Services mail bridge system removes the barrier between dissimilar office systems and provides a critical communications path for our office system users.

### Voltage-Current Relations In Polysilicon Resistors

Wilford D. Raburn

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Polycrystalline silicon is used extensively in the fabrication of integrated circuits both as conductors and as large value resistors. The sheet resistance can be varied over several orders of magnitude with only small variations in the impurity doping. This allows a very wide range of resistors to be fabricated on a single integrated circuit without use of large areas and without major changes in the normal process flow. Since the material is deposited as grains the sheet resistance is controlled primarily by the grain boundaries and only weakly by the doping density. The current is therefore linearly related to voltage only over a small range. This work investigates the current-voltage relations with emphasis on the high current range. A model is developed that predicts avalanche breakdown at very low average electric fields. The model shows that high local electric fields occur at the grain boundaries when the average electric field may be several orders of magnitude less. A range of negative differential resistance is predicted after avalanche occurs. Avalanche breakdown and negative differential resistance onset is predicted as a function of grain size and doping density. Experimental evidence is given to verify the model.



COMPARATIVE STUDIES OF ANTI-LOCK BRAKING SYSTEMS  
(ABS) FOR COMMERCIAL VEHICLES

Peter C. Byrne, University of South Alabama, Mobile, Alabama 36688

Anti-lock braking systems have undergone significant development since they were first introduced in the US in 1975 under Federal Motor Vehicle Safety Standard 121. Since the legislation was subsequently suspended further development took place in Europe. The introduction of the microprocessor into the control loop has been the single most important step towards a dependable efficient system. This has allowed adaptive control techniques to be incorporated into the system. Recently the European Economic Community introduced an updated directive for member states on anti-lock technology, setting the performance requirements to be met before a system is introduced into the marketplace. This paper looks at the technology and how it has evolved to meet the stringent tests laid down in the current directive.

Polycyclic Aromatic Hydrocarbons Emission in residential Stoker Coal combustor. Nanda L. Mukherjee, Dept. of Chemical Engineering, Tuskegee University, Tuskegee, AL 36088.

High emission of carcinogenic polycyclic aromatic hydrocarbons in residential bituminous coal combustor is presently a concern to environment and health. Effects of bituminous coal characteristics on polycyclic aromatic hydrocarbon emissions were investigated to facilitate suitable coal selection. Air flow distribution in combustor tuyeres and coal bed was achieved for efficient retort design. Coal volatile matter, free swelling index and fines showed remarkable effects on PAH emission. Air flow distribution in bed was inconsistent.

A METHOD TO CONVERT ENGINEERING EXPERIENCE TO A NUMERICAL SCALING MODEL. Terry C. Glover, Dept. of Civil Engineering, University of South Alabama, Mobile, Alabama 36688.

The intent of the original research for the State of Alabama Highway Dept. was to define the relationship between existing asphaltic pavement distress and the opinions of experienced highway maintenance engineers. These personnel would include employees whose daily work called for judgements on roadway maintenance throughout the state's highway system. In order to capture this expertise, a method called the Delphi Technique was incorporated which allowed calibration of a linear rating scale to the various degrees of roadway maintenance required (as judged by the engineers). The scope of this paper is to present the Delphi Technique background and show how it was successful in accomplishing the desired task.

ANTHROPOLOGY

GREENSTONE, PHYLLITE, OR SCHIST-ABORIGINAL USE OF "ALABAMA JADE" IN NORTHEAST ALABAMA. Harry O. Holstein, Archaeological Resource Laboratory, Jacksonville State University, Jacksonville, Alabama and Danny Vaughn, Department of Geography/Geology, Jacksonville State University, Jacksonville, Alabama 36265.

Regional archaeological surveys throughout the Upper-Middle Coosa Valley have documented "Greenstone" artifacts consisting of pipes, celts, hoes, and a variety of other cultural items. Aboriginal populations became aware of cultural uses for Greenstone during the Archaic Period, with more diversified applications continuing into the Mississippian Period.

Greenstone is an old field term that does not adequately identify the specific rock type from which these artifacts were made. Pre-historic lithic artifacts are examined under a petrographic microscope in order to determine their mineralogical composition and texture. By comparing artifacts with visually similar rock samples taken from selected outcrop exposures throughout a region of known aboriginal sites, a more precise analysis of the rock type forming these artifacts may be obtained. Thus the term "Greenstone", which is used throughout the literature in describing these lithic artifacts, may be replaced with a more precise rock type which may in fact be found in other varieties reflecting multiple gathering locations. The proximity of Greenstone outcrops within the Upper-Middle Coosa Valley may aid in explaining some of the more utilitarian uses of this lithic material.

IDENTITY AND WEALTH, THE UNEQUAL SPATIAL DISTRIBUTION OF REFINED CERAMICS AT A CLASSIC PERIOD MAYAN CENTER. John W. Cottier, Department of Sociology and Anthropology, Auburn University, Auburn, AL 36849.

The archaeological survey of Dzibilchaltun, in northern Yucatan, recovered extensive architectural information and samples of artifacts within an identified zone of 20 Km<sup>2</sup>. An analysis of the distribution of the 46,384 ceramic sherds in the Dzibilchaltun sample demonstrates a non-random distribution of selected refined ceramics (such as Thin Slate, Fine Orangeware, and Fine Grayware). The apparent importance of scabob, or causeways, and vaulted structures with refined ceramics further suggests an unequal distribution of wealth and power within the late Classic occupation at Dzibilchaltun. These observations have important implications for the understanding of spatial and structural aspects of a Classic period community.

ARCHAEOLOGICAL SALVAGE INVESTIGATIONS AT 1 TU 495; HISTORIC SITE OF THE FIRST STATE BANK: A VOLUNTEER OPERATION. Bruce D. Bizzoco, Social Science Division, Shelton State Community College, Tuscaloosa, Alabama 35405.

During the summer of 1987, a unique opportunity for urban archaeology was present in the city of Tuscaloosa. Due to the revitalization of downtown Tuscaloosa one entire city block was razed by the city in preparation for development. Research indicated that the block razed had survived until 1919. Five groups became involved in the project, with the Tuscaloosa County Preservation Society acting as the coordinating agency. Also included were the Heritage Commission, the City of Tuscaloosa, the University of Alabama, State Museum of Natural History and Shelton State Community College. Early specific planning by each of the organizations key decision makers determined the specific goals that would be established for this joint project. Two major goals were set 1) involve the community by allowing them to participate in the actual running of the dig, 2) excavate the site of the First State Bank in a scientific fashion before it was destroyed. Both goals were met. The excavation lasted three months with over 100 individuals participating in the "dig" and many more stopping by to visit the site. The banking house, vault and well were all located and mapped. A wide variety of artifacts have been recovered and restored. The majority of the artifacts are ceramics of English origin. Shell edged pearlware and transfer ware were present. Brass pins and buttons were also recovered. The site also contained English gunflints, lead shot, Spanish silver coins, green glass hand-blown bottles, and water glasses.

NUBIAN BASKET-MAKING: A 3,000 YEAR TRADITION. Boyce N. Driskell, Alabama State Museum of Natural History, University of Alabama.

Nearly 6,000 baskets and basket fragments from the archaeological site of Qasr Ibrim in Egyptian Nubia have been analyzed in detail by the author and his colleagues in an attempt to elucidate continuity and change in this ancient craft in the middle Nile valley. These data are augmented by a recent study by the author on present-day traditional basket-making techniques and present-day and remembered technical and social practices associated with basketry technology among Nubians from the same area of southern Egypt. Together, these studies allow a rather detailed reconstruction of materials, manufacturing techniques, artifact functions, and economic relevance of this traditional technology for about the past 3,000 years in the middle Nile valley.

## Abstracts

THE MILL CREEK SITE: AN EMERGENT MISSISSIPPIAN FARMSTEAD ON THE BLACK WARRIOR RIVER, ALABAMA. Tim Mistovich, Office of Archaeological Research, The University of Alabama, Moundville, Al. 35474.

Archaeological investigations at the prehistoric Mill Creek site (1Tu265) were performed in 1986 and 1987. Major occupations were related to the Late Woodland West Jefferson phase (AD 900 - 1050) and the Early Mississippian Moundville I subphase (AD 1050 - 1250). The site's significance is in illustrating the form and transition of a small community during the shift from a foraging/hunting subsistence mode to increasing agricultural pursuits. Data related to occupational contexts, material culture, and subsistence are used to support an hypothesis of gradual cultural change at the dawn of the Mississippian period.

MINUTES

ALABAMA ACADEMY OF SCIENCE  
ANNUAL BUSINESS MEETING  
Auburn University  
Auburn, Alabama  
March 25, 1988

1. Dr. Dean Moberly, President of AAS, called the meeting to order at 5:45 P.M.

2. The President asked for the "Report of the Counselor to the AJAS." Dr. Eugene Omasta sent the following report to the Secretary after the meeting:

The 1988 annual meeting was hosted by Auburn University at Auburn and like all previous meetings, was shared with the Alabama Academy of Science.

The winners of the scientific paper competition were:

Physical Science	1st place	Christina Rodriguez	Auburn
	2nd place	Sandra Padgett	Jackson Academy
Biology	1st place	April Johnson*	Sidney Lanier
	2nd place	Claude Denton	Randolph
Humanities	1st place	Tina Beams	Hillcrest
	2nd place	Michele Wallace	Sylacauga
Engineering	1st place	Richard Hall	Athens
	2nd place	John Katz	Sidney Lanier
Mathematics	1st place	Shreyas Vasanawala	Sidney Lanier
	2nd place	Ajai Saini	Sidney Lanier

\*Overall winner who will represent Alabama in the paper competition that is a part of the National JSHS Symposium at the University of Florida on May 18-21, 1988. The other 1st place winners will accompany April Johnson on the expense paid trip.

Other awards were:

Expense paid trip to the University of Florida and the Army Award (\$300 for supplies and a certificate) - Teacher-sponsor of the overall winner:

Jennie McConnell

Sidney Lanier

AAAS - A subscription to a scientific magazine:

Wendy Mann  
Sandra Padgett

T. R. Miller  
Jackson

## Minutes

Grant for a research project:

Sandra Padgett	Jackson Academy	\$200
Danny Jeter	Mobile County	\$200

Outstanding Teacher (more than five years) - \$100 and a certificate:

Jennie McConnell	Sidney Lanier
------------------	---------------

Outstanding Region - An engraved plaque:

Southeast - Regional Counselor Donnie Hatcher

Newly elected officers for 1987-88:

President	Christopher Daniel	Shady Mountain Christian
Vice-President	Kelly Cain	Brewer
Treasurer	Shreyas Vasanawala	Sidney Lanier
Secretary	Angela Dewberry	T. R. Miller

Many people deserve special thanks for their efforts in support of the 1988 annual meeting, including: Marllin Simon and W. D. Perry for serving as local arrangements persons for AJAS and in making plans and arrangements for the meeting rooms, motel rooms, science experiences, and other activities; Bob Lishak for serving as the overall local arrangements person in planning and assisting AJAS at this meeting; Donnie Hatcher as counselor of the host Southeast Region and Leigh Nix as teacher-counselor, for arranging the dance, gathering gifts and materials for the students from local merchants, assisting with registration, and planning and assisting with the meeting; the state officers for their support and assistance - Champ Thomaskutty (President), Richard Hall (Vice-President), Russell Brockwell (Treasurer), Chavigny Beasley (Secretary); Richard and Champ deserve credit for designing this year's T-shirt and banners for the Alabama Academy of Science and Alabama Jr. Academy of Science. Also, special appreciation is extended to the judges of the paper competition for both judging and their concern for student scientific development - Melissa Buie from the Auburn Physics Dept.; W. D. Perry, John Aull, and C. H. Ward from the Auburn Chemistry Dept.; Ed Jones and Tom Padgett from the Auburn Engineering Dept.; Alfred May and Bryan Truelove from the Auburn Botany and Microbiology Dept.; Ed Slaminka from the Auburn Mathematics Dept.; W. F. Trimble from the Auburn History Dept.; Mitzi Roland and Anna Smith from the Troy State University Psychology Dept., William Smith from the Troy State University Computer Information Science Dept.; and also the associate counselors for their continued dedicated service to AJAS - Betty Bigham and B. J. Bateman.

We also appreciate the continued support of the Senior Academy in AJAS activities and especially the support of this years' President, Dr. Dean Moberly.

# Minutes

3. The President called for the "Report of the State Coordinator of Science Fairs." Ms. Elsie Spencer mailed the following report to the Secretary:

## ALABAMA FINALISTS

FAIR DIRECTOR	FINALISTS	SCHOOL
Mobile Dr. Jim Langdon USA	Terry Kay Moore Grand Bay, AL	Mobile Co. High
	Erich Mueller Mobile, AL	St. Paul's Episcopal
West Central-West Dr. David Heggem	David Hebbler Northport, AL	Tuscaloosa
	Kathleen Caddis Duncanville, AL	Hillcrest High
East Mr. W. A. Shands	Felecia Y. Salary Montgomery, AL	R. E. Lee
	April M. Johnson Montgomery, AL	Lanier High
Southeast Dr. Bill Norman	Thomas A. Blackstock Andalusia, AL	Opp High
	Robert Baldree Opp, AL	Opp High
Northeast Dr. Arthur Bacon	Sam Timothy Reaves Gadsden, AL	Emma Sansom High
	Robby Randall Roberson Childersburg, AL	Childersburg High
North Mr. George Williams	Hugh Greene, Jr. Somerville, AL	Brewer High
	Taja Jacobsen Huntsville, AL	Huntsville High
	Sam Houston, Jr. Decatur, AL	Decatur High
	Richard N. Hall Athens, AL	Athens High

# Minutes

Central  
Dr. Lee Summerlin

Naoyuki Saito  
Homewood, AL

Homewood High

David Lin  
Birmingham, AL

Shades Valley RLC

The winners of the Alabama Science and Engineering Fair will be added to this list when they are selected April 22-23, 1988, at Calhoun State Community College.

4. Dr. Moberly called for the "Report of the Secretary." Dr. Ann Williams presented the following report:

Membership, March, 1987 . . . . .	874
Members dropped for non-payment of dues (Sept., 1987) . . . . .	-123
Members deceased . . . . .	-1*
New members added . . . . .	+119
Members reinstated . . . . .	+9
<hr/>	
Total membership, March 23, 1988 . . . . .	878
Net difference from March, 1987 . . . . .	+4

## MEMBERSHIP BY SECTIONS

<u>Section</u>	<u>March, 1988</u>	<u>March, 1987</u>	<u>Change</u>
1	261	235	+26
2	88	84	+4
3	47	49	-2
4	28	34	-6
5	87	90	-3
6	57	68	-11
7	37	42	-5
8	38	33	+5
9	144	152	-8
10	58	54	+4
11	25	28	-3
99	8	5	+3
			<hr/>
			+4

\*C. E. Smith, Tuscaloosa, AL

During registration for the meeting, 16 new memberships and one reinstatement have been added to the roll, bringing the total membership to 896.

5. The President asked for the "Report of the Place of Meeting Committee." Dr. Joe Thomas was unable to attend but left the following report to be given by Dr. Williams:

The AAS Place of Meeting Committee composed of Dr. Robert S. Lishak, Auburn University; Dr. Robert P. Bauman, UAB; Dr. Elizabeth S. Sheldon, AUM; Dr. David H. Nelson, USA; and Dr. Joseph C. Thomas (Chairman), UNA, wishes to report that the following future meeting sites have



## Minutes

been established and confirmed by the respective institutions and the Executive Committee of the Alabama Academy of Science.

1989 -- Birmingham Southern College  
1990 -- Mobile College  
1991 -- Jacksonville State University  
1992 -- The University of Alabama  
1993 -- The University of Alabama in Huntsville

It is felt that this committee should not be negotiating for meeting sites beyond 1993.

6. The "Report of the Resolutions Committee" was next called for by Dr. Moberly. Dr. Moberly announced that Dr. Linda Reed would serve as the Resolutions Chairperson. Four resolutions were approved at the Executive Committee meeting: resolutions of appreciation were presented to Dr. James Martin, President of Auburn; and to Dr. Robert Lishak and the Local Arrangements Committee (Drs. Roland Dute, Christine Sundermann, Olivia Campbell, Charles Savrda, Marllin Simon, W. D. Perry, P. A. Salpas, and R. E. Rowsey); resolutions of sympathy were extended to the families and friends of deceased members Drs. C. Earl Smith, Jr. and Howard L. Holley.

Dr. Moberly called for a moment of silence in remembrance of our deceased members.

7. Dr. Moberly then asked for the "Report of the Research Committee." Dr. Garstka reported the following:

Research Grants have been awarded by the Research Committee to the following students:

Charles Mayfield (AU)	\$250	Holley Handley (AU)	\$250
Gene Hines (UAB)	250	Carolyn Clark-Daniels (UA)	250
Michelle Acree (UA)	250	Paul Stone (AU)	250
Joan Grant (UAB)	250	Daureen Nesdill (AU)	125
Uchekuku Okike (Oakwood)	125	Edward Kamkan (Oakwood)	125

Winners of the Research Awards for the following sections were selected by the Section and Session Chairpersons:

Biological Sciences: Harold Spears      Tuskegee University

Chemistry: Dilip Paul and R. D. Cantrell      Auburn University (Tie)

Health Sciences: Brenda Walker      UA

Engineering and Computer Sciences: Dalton S. Nelson      UAB

The Research Committee would like to propose a change in the By-laws with regards to the Student Research Awards competition which is presently limited to those students giving oral presentations. The committee proposes that a new category for competition be created for students presenting posters in all sections at the Annual Meeting.

## Minutes

Dr. Garstka offered thanks from the committee to all Section and Session Chairpersons for their assistance in evaluating the student papers.

Dr. Barker suggested that a formal written report on the proposed change in the By-laws be sent to the new President by the Committee Chairperson and be considered at the Fall Meeting.

8. Dr. Moberly asked for the "Report of the Nominating Committee." Dr. Ken Marion submitted the following list of nominees, all of whom were elected unanimously:

Second Vice President: Mike Lisano  
Secretary: Ann H. Williams  
Counselor to the AAAS: Joe Free  
Associate Counselor-JAS: Betty Bigham  
Trustees: Edgar Gentle  
          Albert Bryan  
          Dan Holliman  
          S. William Cole  
          Charles Baugh (Filling unexpired term of Dr. Lisano)

### Section Officers:

#### Section I - Biological Sciences

1. Tom Jandebur, Vice-Chair (Filling one-year vacancy)

#### Section III - Geology

1. Charles E. Savrda, Chair
2. David T. King, Jr., Vice-Chair

#### Section IV - Forestry, Geography, Conservation, and Planning

1. Karen Cagle, Chair
2. Surendra Mathur, Vice-Chair

#### Section V - Physics and Mathematics

1. P. C. Sharma, Chair
2. Kent Clark, Vice-Chair

#### Section VII - Science Education

1. Donna Bentley, Chair
2. Larry Rainey, Vice-Chair

#### 9. OLD BUSINESS

1. The President announced that the Academy Directory is in the process of being compiled from the 300+ submissions received last fall. Mrs. Jackie Gilbert is preparing the edited entries for publication in the *Journal*. The Directory will be made available to industry, the Chamber of Commerce, the Governor's Office, the Alabama Resource Center, and the Alabama Development Office.

10. There being no new business, the business meeting was adjourned at 6:07 P.M.





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## AN OVERVIEW OF LEAD TOXICITY<sup>a</sup>

Ronald N. Hunsinger and Terrie W. Brasher  
*Department of Biology and the School of Pharmacy*  
*Samford University*  
*Birmingham, AL 35229*

### INTRODUCTION

The chemical elements lead, arsenic, antimony, cadmium, mercury, and thallium are classified as heavy metals. All have atomic weights greater than the common essential elements of the body, i.e., sodium, potassium, or calcium. Of these metals, lead has been the most intensively studied. From an historical standpoint, its use dates back to 3500 B.C., where, in the Roman empire, it was used in industrial endeavors and was a primary component of aqueduct and pipe systems (1). Some speculation even exists that chronic lead toxicity may have significantly contributed to the fall of the Roman Empire (2).

Today, detailed toxicological, pharmacological, epidemiological, and exposure data are available, and the metal unequivocally presents a broad range of health problems. Lead may enter the body by several routes and, once absorbed, can generate a wide-spectrum of target organ toxicity. It is in every sense of the word, a "classic example of an environmental disease" (3). As one estimate suggests, a lowering of blood lead levels from a national average of 17- to one of 10- $\mu\text{g}/\text{dL}$  would result in a minimum saving of 50,000 heart attacks, 70,000 strokes, and 25,000 deaths over a 10-year period (4).

In light of the high risk for lead exposure in certain Alabama regions, the federal, state, and local health agencies have recently become concerned about possible deleterious effects to the public. The primary objectives of this report are to identify possible sources of exposure to lead, to describe the metal's toxicokinetic properties, and to review its toxic effects on major target organs.

#### *The Problem Today*

Lead entry into the body may occur as the result of exposure to several potential sources. The consumption of lead-containing moonshine whiskey is still a possible source of lead contamination and will be discussed in connection with the renal effects of lead (see below). Though corrective measures have been taken for the use of lead-based solders and house-paints, these sources also continue to pose health hazards in older dwellings (5-6). Rey-Alvarez and Menke-Hargrove (7) recently cautioned that the de-leading of houses might ironically precipitate acute episodes of lead toxicity, unless residents strictly heed

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<sup>a</sup>Manuscript received 21 July 1987; accepted 5 July 1988.

## An Overview of Lead Toxicity

warnings against prematurely returning to the dwelling. At one time, the widespread use of automobile gasoline, containing organic forms of lead, was a major source of environmental contamination. In 1968, for example, 260,000 tons of lead were used as gasoline additives (8). These tetramethyl- and/or tetraethyl-lead compounds were added to reduce engine "knock" but were converted to inorganic lead oxides during the combustion process. Today, gasoline sources are of lesser concern, since the use of leaded-fuel has drastically declined. To illustrate this point, it is only necessary to look at recent data compiled by the Jefferson County Health Department's Air Pollution Control Division (9):

LEAD SAMPLING  
(Quarterly Mean Levels in Micrograms per Cubic Meter)

Sampling Site	1984				1985			
	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
East Birmingham (I-59)	0.69	0.56	0.36	0.45	0.46	0.37	0.30	0.25
East Thomaa (Finley Avenue)	0.94	0.77	0.46	0.67	0.50	0.43	0.28	0.34
Industrial site A	5.37*	0.61	0.52	2.46*	1.42	0.85	0.43	0.60
Industrial site B	2.96*	0.39	0.64	1.89*	0.68	0.84	0.50	0.46
Industrial site C	-	-	-	-	-	-	-	0.79
Industrial site D	-	-	-	-	-	-	-	6.27*
Industrial site E	-	-	-	-	-	-	-	1.32

Standard: Quarterly arithmetic mean level should not exceed 1.5 micrograms of lead per cubic meter of air.

\*Violation of Standard.

-(site not operating during sampling period).

Industrial sites A-E represent sampling sites in close approximation to a lead recycling industry located in a rural setting.

In the above table, the Interstate-59 and Finley Avenue monitoring sites represent heavily trafficked urban areas, far removed from any lead-based industries. Sampling at both of these sites reflected lead levels far below the EPA threshold values of 1.5  $\mu\text{g}$  per cubic meter. When the data from the rural monitoring sites surrounding a secondary\* storage battery facility are examined, it can be seen that extremely high lead levels were recorded during the first and fourth quarters of 1984 and the fourth quarter of 1985. Comparing the I-59 and Finley Ave. values with the latter data strongly suggests that the major source of the extremely high lead levels in the industrial area cannot be from combustion of leaded fuels. In other words, in extremely high volume traffic areas, the highest lead level reported over a two year period was only 0.94  $\mu\text{g}$  per cubic meter. On the other hand, levels in the rural, isolated industrial region reached as high as 6.27  $\mu\text{g}$  per cubic meter, a value which is about 4x the minimum acceptable standard. Thus, lead-based industries and their surroundings represent a particularly high risk exposure source due to the generation and release of lead fumes and oxides. Much of our current toxicologic information on lead has been collected in or near the approximately 200 battery plants in the United States (10). Two secondary plants are located in Alabama.

\*If a battery factory makes new grids, it is classed as a primary storage battery plant; if it recycles old battery plates, it is classed as a secondary storage battery facility.

### *Absorption and Distribution*

The various salts and oxides of lead all act in a similar fashion, once absorbed into the body (11). With these inorganic forms, absorption can occur from the gastrointestinal tract or the respiratory tract; thus, contaminated food, water, and air may serve as carrier vehicles for the metal (11). Dermal absorption of inorganic lead compounds is usually insignificant; however, most organic forms of the metal are readily absorbed through the skin (11).

Gastrointestinal absorption of lead is much faster in children and infants than in adults (3). In addition, Ziegler et al. (12) reported that infants and young children absorb approximately 50 percent of dietary lead and retain one-half of this absorbed fraction. In contrast, adults only absorb 5-10 percent of dietary lead and retain very little of this amount (13). From these studies, it is clear that children represent a high risk population for lead toxicity.

A major consideration in the toxicokinetics of lead is that while blood lead levels may be useful in detecting very recent episodes of lead exposures, they may not be a good index of chronic exposure to low levels of the metal. The reason for this lack of correlation is that after its absorption, lead is rapidly transferred from the blood to several major tissue reservoirs, i.e., bone, liver, brain, and kidney (11). Once sequestered in these tissues, the elimination of lead from the body is an extremely slow process, requiring as long as twenty years to clear from bone (14). Hammond has shown that 50 percent of an injected dose of lead is still present in the body 60 days after dosing (15), and some workers indicate that the brain, bone, and liver lead levels may be 5 to 10 times the blood lead values (12).

One test by which health authorities may diagnose chronic exposure to lead is the calcium disodium EDTA urine test, which more reliably reflects the total body lead burden (16-18). The patient is given, intravenously or intramuscularly, EDTA, a chemical that chelates existing lead in the blood. Once trapped, this lead is no longer part of the pool of free lead. Thus, by mass-action, stored lead leaves the tissue reservoirs to re-establish a steady-state equilibrium with the blood. As the EDTA continues to capture the blood lead, more and more tissue lead is mobilized. The EDTA-bound lead is excreted in the urine, which is collected and analyzed over a 24 h period. Other tests, such as the FEP test (free erythrocyte protoporphyrin) or the lead levels found in shed deciduous teeth, have been used as an index of body lead burden (19). Conventional lead excretion occurs via the urine, bile, and through the exfoliation of hair (5,11).

### *Biological Effects*

A) General aspects - Lead poisoning may be either acute or chronic. Acute toxicity would result from accidental or suicidal ingestion of a high dose of lead salts or oxides; around 0.5 g of lead is considered to be a fatal dose (8). All or some of the following symptoms would occur within a very short time after such exposure: metallic taste, abdominal

pain, vomiting, diarrhea, dark stools, scanty urine output, collapse, coma, and possible death (8).

Chronic lead poisoning (plumbism from the Latin word for lead, *plumbum*) is of a major concern in today's society and results from the accumulation of small amounts of lead to toxic levels. It is no exaggeration to say that in our industrial age, lead is ubiquitous. Supportive of this statement is the fact that average blood lead levels of adults in the United States today range from 17-25  $\mu\text{g}/100\text{ ml}$ ; toxic levels are considered to be around 80  $\mu\text{g}/100\text{ ml}$  (3-4). The symptoms which can possibly develop from chronic exposure to lead include:

1. Early - loss of appetite, weight loss, constipation, apathy or irritability, occasional vomiting, fatigue, headache, weakness, metallic taste, lead line on gums, motor disturbances, and anemia.
2. More advanced - intermittent vomiting, irritability, nervousness, incoordination, vague pains in arms, legs, joints, and abdomen, sensory disturbances of the extremities, paralysis of extensor muscles of the arms and legs with wrist and foot drop, disturbances of menstruation, and possible abortion (8).

B) Effects on the Central Nervous System - Often associated with either chronic or acute exposures to higher doses of lead is a condition known as "lead encephalopathy." In this condition, the following overt symptoms might be possible: mental dullness, restlessness and irritability, headaches, muscle tremor and ataxia, memory loss, convulsions, coma, and epilepsy. Children seem to be the most susceptible population to the above effects. One expert described the lead-induced mental deterioration in children as follows, "The history of these children indicates normal development during the first 12-18 months . . . followed by a steady loss of motor skills. They may have severe hyperkinetic and aggressive behavior disorders . . . more subtle CNS toxicity may result." (5). Another medical source depicts lead poisoning in children as follows, "In children, chronic plumbism is associated with mental retardation, seizure disorders, aggressive behavior disorders, developmental regression, and anemia. Lead encephalopathy may mimic bacterial meningitis, except that fever is uncommon"(20).

Subtle behavioral effects, particularly in children, are a major concern with exposure to lower lead levels. Studies suggest that very low blood levels (i.e., 40 to 80  $\mu\text{g}/\text{dL}$ ) in children result in learning deficiencies as determined by psychometric performance and neurological tests (21). Among many authorities there is a general consensus that subtle effects involving cognitive and/or sensorimotor impairment occur without the overt signs of lead poisoning (11). Bellinger et al. (22) investigated the effects of low level prenatal and early postnatal lead exposure on 249 infants. It was found that scores at 6 and 12 months of age on the Mental Development Index (MDI) of the Bayley Scales of Infant Development were inversely proportional to the infants' umbilical cord blood lead levels at birth. The relationship between mental performance and umbilical lead levels was statistically significant. However, infant blood lead levels at the time of testing (i.e., 6 or 12 months of

age) did not significantly correlate with performance. Such data suggest a long-lasting effect of lead on the mental development of infants.

In another study, abnormalities in fine motor control and behavior (negativism, distractibility, and constant need for attention) have been related to low blood lead levels (23). Also, Needleman et al. (24) found that the frequency of non-adaptive classroom behavior increased in a dose-related fashion with the amount of lead accumulated in teeth.

From the above studies, one can see that it is quite possible that the intellectual performance of children in the general population is being decreased as a result of environmental exposure to lead. Two EPA scientists recently stated in an article in *Drug Metabolism Reviews* (4) that "children whose exposure to lead was first discovered as a result of community blood lead sampling programs and whose blood lead levels were above 40  $\mu\text{g/dL}$  were shown to have major learning disabilities even though by the time they had begun formal schooling their blood levels were normal. Five years after they were first documented to have high blood levels, seven times as many of these children were found to be repeating grades or were being referred to the school psychologist as compared to their classmates. Children living in a lead smelter community whose blood levels were slightly higher than a similar unexposed cohort of children had decreased perceptual motor integration, changes in reaction time performance, and changes in four behavioral rating dimensions, including distractibility."

Several studies have proposed that neurotransmitter alterations account for the psychomotor and cognitive dysfunctions seen in lead poisoning. For example, lead has been shown to both activate and depress dopamine systems (25-26). While the dosage of lead used may in part explain such discrepancies, it has also been shown that dopaminergic systems in different parts of the brain respond oppositely to equidoses of lead (27-28). Lead-induced increases and decreases of dopamine synthesis in the nucleus accumbens and striatum, respectively, have been reported (29). Dopamine receptor densities were found to be reciprocally related to dopamine concentrations in these two areas. Other studies have reported similar regional differences in both dopamine and norepinephrine content in response to lead (30-31).

Changes in CNS cholinergic functioning have been reported as a consequence of lead-treatment (26,32). However, such changes are seen only with extremely high doses of lead and are therefore not felt to represent a specific mechanism directly involved in subtle effects of lead (26).

High doses of lead have also been shown to reduce the uptake and release of GABA, alter GABA transaminase and glutamic acid decarboxylase, and increase GABA synthesis (33). Govoni et al. (28) failed to confirm the effect of lead on GABAergic enzymes, but did observe increases and decreases in GABA receptor densities in the cerebellum and striatum, respectively. Some evidence exists to support the notion of an indirect effect of lead on GABA systems. It has, for example, been noted that some CNS symptoms of lead toxicity are similar to those seen

in acute intermittent porphyria (34-35). In both conditions, excessive levels of amino-levulinic acid (ALA) accumulate in the blood (36; also see section E below) and may cross the blood-brain-barrier (36). *In situ* ALA synthesis in the CNS is also possible (37). Thus, either pool of ALA might be increased, as a result of lead exposure. These findings have relevance to the effects of lead on GABA, since Brennan and Cantrill (38) found that  $K^+$ -stimulated GABA release was inhibited by ALA.

Another theory for lead's CNS effect, which is also related to the metal's hemopoietic effects, involves the hepatic heme-dependent enzyme, tryptophan pyrrolase. Lead has been shown to reduce the activity of this enzyme (39), supposedly as a result of decreased heme availability. Under these conditions, plasma levels of tryptophan, 5-HT, and 5-HIAA rise, due to decreased tryptophan pyrrolase activity, and may be responsible for some features of lead toxicity. It is known, for example, that highly elevated tryptophan levels can mimic many of the CNS effects seen in lead poisoning (39). Also supportive of this theory is the fact that concurrent administration of heme with lead ameliorates many of the neuropathological aspects in cultured mouse ganglial cells exposed to lead alone (40).

As can be gleaned from the above discussion, the mechanisms by which lead may cause CNS dysfunction are complex and far from conclusive. Added to this complexity are numerous "pitfalls" inherent to studies attempting to correlate neurochemical imbalances and behavior. Cory-Slechta (1) and Shellenburger (41) give excellent overviews of the problems encountered with animal models of lead toxicity and ascribe much of the current discrepancies to species, strain, and within subject variability, and the use of extremely high, perhaps practically irrelevant, doses of lead used in many studies. Nutritional status should also be taken into account in lead studies, since  $Ca^{++}$ ,  $Zn^{++}$ ,  $Cu^{++}$ , and  $Fe^{++}$  have been shown to greatly influence biologic responses to lead (1). Indeed, many commercial animal diets have been shown to be overly fortified with  $Ca^{++}$  and  $Fe^{++}$ . The use of commercial breeder-supplied timed-pregnancy animals may, in prenatal lead studies, also present a problem, due to the many potential stresses involved with the shipping of pregnant females (41).

A recent study (42) takes into account many of the design problems mentioned above, and therefore gives a more credible profile of lead's neurochemical effects. Female rats were treated with a very low level of lead (1 mg/kg/day) from mating until the end of lactation. Offspring were similarly treated throughout lactation. This threshold level of lead mimicked in rats the hyperkinetic syndrome occurring in children. Plasma levels of  $Zn^{++}$ ,  $Ca^{++}$ , and  $Cu^{++}$  were measured throughout the study and were found to be within normal ranges. In this animal model, Baraldi and co-workers found a reduction in low affinity,  $Na^+$ -independent GABA binding in the cortex, brainstem, and cerebellum; an increase in the affinity of dopamine receptors in the striatum (possibly as a result of decreased dopamine content in this area); a marked increase in the number of opiate receptors in the hypothalamus; a decrease in beta-enkephalin; and an increase in met-enkephalins.

Aside from the neurotransmitter imbalances discussed above, lead has also been implicated as a causative agent in dendritic and axonal destruction (43-44). Dendritic plasticity is felt to be needed in order for neuronal connections to be formed in learning and memory (45). Some evidence suggests that morphological alterations of the dendrites results from a  $\text{Ca}^{++}$  activation of actin-like contractile filaments, and this process may be vulnerable to lead (45-49).

C) Effects of Lead on the Kidney - The known effects of lead on the kidney include glomerular and tubular damage, volume depletion, renal interstitial damage, gout, and hypertension. Many of these effects were first noted in the southeastern United States, where consumption of moonshine whiskey made in lead-containing stills was common (50-52). Analysis of lead content in some moonshine batches revealed lead levels as high as 74 mg/L (5), and as late as 1980, surveys have shown lead levels in illicit whiskey to be as high as 5.3 mg/L (53). The sources of lead in the moonshine often result from the use of lead solder in the copper condenser coils of the distillery apparatus (5).

The renal effects of lead are expressed functionally in that GFR and effective renal plasma flow are reduced (54-56); aminoaciduria, glycosuria, and volume depletion occur; and, at end-stage renal failure, azotemia is seen (55, 57-58). These chronic lead-induced nephropathies can apparently be reversed with chelation therapy, provided that the azotemia stage has not been reached (55).

It is not clear how lead causes these functional defects; however, several possible morphological and biochemical correlates have been proposed. Volume depletion may be related to lead's known inhibitory effect on  $(\text{Na}^+ - \text{K}^+)\text{-ATPase}$  dependent  $\text{Na}^+$  transport in the proximal tubules (59). Swollen proximal tubular cell mitochondria have been noted in animal models of lead toxicity and could be related to the tubular-cell damage (60-61). The hyperuremia and tubular uric acid deposits associated with lead-exposure may be due to a reduced GFR, secondary to volume depletion (62), alterations of tubular uric acid secretion, or increased uric acid production (62-63). Hypertension is believed to result from general renal failure or may be caused by pre-renal disease changes in the arterioles of the kidney (54). Additionally, reductions in urinary levels of the vaso-dilator, kallikrein, have also been reported as a result of lead-exposure (64).

D) Effects of Lead on the Red Blood Cell - Hypochromatic/microcytic anemia is an early symptom of lead poisoning, since the hematopoietic system is one of the most sensitive tissues to lead effects (14). At least two detrimental effects of lead predispose humans to anemic conditions. First, the red cells can become very fragile, which results in membrane rupture and premature destruction of the cell. A second effect involves decreased hemoglobin synthesis.

The biochemical mechanisms by which lead causes these alterations are those involved with either maintaining the cell membrane integrity or with the synthesis of heme. For example, the proper fluidity of red cell membranes is dependent upon the correct ratio of cholesterol to

phospholipids. Increases in membrane cholesterol content may lead to excessive rigidity of the plasmalemma and an increased susceptibility to lysis (65-67). In this respect, lead has been shown to inhibit hepatic lecithin-cholesterol acyltransferase, resulting in an increased red cell membrane cholesterol/phospholipid ratio (67).

Membrane pumps are also critical in maintaining the red cell membrane integrity. The  $(Na^+ - K^+)$ -ATPase found in erythrocyte membranes has a sulfhydryl component that is sensitive to inhibition by lead (68-70). The resulting disturbance of transmembrane osmotic balance may certainly render the cell more susceptible to swelling and lysis.

A large proportion of the red cell's metabolism is directed toward stabilization of the membrane (11). In this respect, several studies describe a lead-induced reduction in the activity of pyrimidine-5'-nucleotidase (71-74). Cellular energetics may thus be impaired by dysfunctions in pyrimidine nucleotide metabolism. Also, glutathione (a major anti-oxidant) levels in the red cell decrease as a result of lead (75), making the red cell more susceptible to oxidation.

The effects of lead on heme synthesis are well-documented. At least three key steps in the heme biosynthetic pathway are known to be affected. First, lead indirectly stimulates delta-aminolevulinic acid synthetase, causing a build-up of aminolevulinic acid (ALA) (11, 76-78). This effect occurs via a loss of negative feedback, as other enzymes "down-stream" in the heme pathway become inhibited (11). The subsequent steps affected by lead are d-ALA dehydratase and ferrochelatase. ALA-dehydratase has been shown to be directly inhibited by lead; however, reactivation of this enzyme is possible upon addition of a sulfhydryl source such as dithiothreitol (79-81). The exact mechanism by which lead impairs ferrochelatase function is not certain. It may be through an indirect mechanism, such as a blockade of iron-transport into the mitochondria (79, 82-84). Alternatively, lead may directly inhibit ferrochelatase (4). Whatever the case may be, the end result is that the production of heme decreases, and heme precursors, such as protoporphyrin, increase (85). Hart et al. (86) found that in rabbits acutely exposed to lead, free protoporphyrin initially increased, but was later surpassed by a rise in a  $Zn^{++}$ -containing protoporphyrin, which is more commonly associated with lead poisoning. In genetically related porphyrias, free protoporphyrin is predominant and can readily diffuse out of the cell to accumulate in the skin, often causing photosensitization (87-88). This is not the case in lead-poisoning, since  $Zn^{++}$  protoporphyrin becomes trapped in the red cell (87). Heme oxygenase activity is also often increased as a result of lead exposure, leading to further decreases in the functional heme pool (77, 89).

E) Effects of Lead on the Reproductive System - Prior to the implementation of modern industrial hygiene, infertility in women was commonly associated with occupational lead exposure (90). It is certainly well known today that high doses of lead may decrease fertility in females and increase the risk of stillbirths (14). Some data do suggest alterations in reproductive functioning in females as a result of low level, chronic exposure to lead; however, the results are still



considered to be equivocal because of various experimental design flaws, as reviewed by Zielhuis and Wibowo (91). Exposure of laboratory animals to lead has resulted in irregular estrous cycles, ovarian cysts, and decreased corpora lutea (92); decreased ovarian weight and repressed endometrial proliferation (93); menstrual cessation (94); and functional alterations in the hypothalamic-pituitary-gonadal axis (95).

Severe gonadal damage has also been reported in males after high dose exposure to lead (14), but relatively little information is available regarding reproductive dysfunctions in men exposed to lower lead levels. Lancranjan et al. (96) found an impairment in testicular function in males which appeared to be a direct result of lead, since the hypothalamicopituitary axis functioned normally. Cullen and co-workers (97) studied seven men displaying symptoms of lead intoxication as a result of occupational exposure and found defects in thyroid function, decreased glucocorticoid production, and spermatogenic defects such as oligospermia and azoospermia. In this study, serum testosterone levels were found to be normal. Cullen was not able to readily or completely reverse these alterations with chelation therapy.

Numerous animal studies have confirmed the gonadal insults of lead, such as decreased spermatogonial cells and desquamation of the seminiferous tubules (92, 98-99), decreased testicular enzyme activities, and decreased androgen and FSH binding (100-101).

#### F) Laboratory Findings in Lead Poisoning (8) -

1. Anemia.
2. Blood lead levels > 20 µg/dL (40 µg/dL or greater suggests the need to identify and eliminate the source of the contamination).
3. Urinary lead excretion > 0.08 mg/day or excessive amounts of heme precursors in the urine. Urinalysis may also indicate high levels of urinary glucose, blood, or protein.
4. Lumbar puncture may reveal elevated protein levels and increased cerebrospinal pressure.
5. X-ray examination of the wrist areas often reveals an unusual sequelae, especially in children between the ages of 2 and 5. The phenomenon is referred to as a "lead line" and results from an accumulation of lead in the ends of growing bones.

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ESTABLISHING APPROPRIATE SOCIAL BEHAVIOR  
THROUGH VOCAL AND VISUAL ANTECEDENTS<sup>1</sup>

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ABSTRACT

A twenty-three (23) year old institutionalized retarded male was the subject of a multiple baseline research project to reduce physical and verbal aggression. The project used vocal and written antecedent and consequential stimuli in an effort to decrease maladaptive fighting and swearing behavior. The investigators not only provided vocal instruction on how to avoid fighting and swearing, but they provided brief written instruction to which the client referred when the investigators were not present at the institution. Generalization of appropriate behavior was promoted by varying the location of the therapy sessions and rotating assistant staff therapists. Due to the significant decrease in both of the aggressive behaviors, the client was allowed to move from dormitory residence to transitional housing outside of the institution to prepare for group home life. This project was conducted at and with the approval of the J. S. Tarwater Developmental Center, Wetumpka, Alabama.

INTRODUCTION

Improving the social skills of mentally retarded adults has been the subject of a great deal of research in recent years (Bates, 1980; Berler, Gross and Drabman, 1982; Bornstein, Bach, McFall, Friman and Lyons, 1980; Foxx, McMorow and Schloss, 1983; Turner and Hernsen, 1978). The impetus for this research has been a continued trend to deinstitutionalize maladaptive individuals and to encourage their successful community placement. In order for retarded individuals to be assimilated and accepted in to the local community, however, they must be proficient in a number of basic social skills and must also have their maladaptive behaviors under good stimulus control.

In efforts to achieve this goal, both traditional psychotherapy and behavior modification therapy have been the basis for programs which have attempted to improve social skills in retarded adults. While both of these types of therapy have had some success, a comparison of these two methods indicates that, in general, behavior modification techniques are more successful (Giles, 1983a; Matson and Senators, 1981) for two basic reasons: verbal and memory limitations; and a lack of improvement outside an institutional setting.

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## Establishing Appropriate Social Behavior

A primary reason for this greater success using behavioral techniques is that retarded individuals have verbal and memory limitations that impair communication between therapist and client during traditional psychotherapy sessions. Because good verbal skills are essential for effective psychotherapy, behavioral techniques lend themselves more readily to therapy with retarded individuals (Giles, 1983b).

The remediation of social excesses and deficits in retarded individuals poses a second problem because of the lack of improved social skills generalization to a less restricted environment. In many cases, behavior therapy improves the social skills of the retarded individual but this improvement may occur only in the therapy setting (Bates, 1980; Berler, Gross and Drabman, 1982). In order for therapy to be an effective training tool used to help promote deinstitutionalization of capable individuals, generalization of the improved social skills into the community setting is essential. The new behavior is not beneficial to the client or society if it only occurs in a restricted environment.

The goal of this project was to reduce excessive fighting and swearing behavior in a retarded individual for the purpose of achieving residence outside of the Institution (to prepare for group home life).

### *METHOD*

This program was designed to use antecedent and consequential stimuli. The vocal antecedent stimuli consisted of vocal instruction and discussion. The vocal consequential stimuli were reinforcers, such as telling the client how well he was doing. The visual antecedents were cards with written instructions, while the visual consequential stimuli were cards with written reinforcers (the tally of days without a fight). Because the therapist could not always be with the client to give verbal instructions and reinforcement, the visual instructions were used as visual cues to maintain the appropriate behavior during the client's daily routine.

### *SUBJECT*

The client was a 23-year old white male who had been institutionalized since 1967 at age 7. The client has mild mental retardation with an IQ of 68. Although the client is a personable, alert, and outgoing individual who has acquired the necessary living skills, he has maladaptive fighting and swearing behaviors that have prevented successful group home placement. Two previous group home placement attempts failed because of these maladaptive social behaviors. The first attempt lasted two months (August to October, 1980). The second group home placement attempt lasted only a few weeks in 1981.

### *PROCEDURE*

A multiple baseline design across the behaviors was used. The two monitored behaviors included physical aggression (fighting) and verbal aggression (swearing). The multiple baseline procedure is a within subject design that allows the subject's own behavior to be segmented into

a "control phase" and an "intervention phase" for comparison purposes. The strength of this design lies in the technique of staggering the onset of the intervention phase for the second behavior. When treatment is applied to the first behavior (fighting) but not to the second behavior (swearing), the targeted fighting behavior declines while swearing still exists. It is only until swearing is targeted for intervention that it will decline. Experimental control is determined when viewing the behavioral differential at the staggered line.

The Institution's staff and the investigators jointly agreed that the data collection process would be a function of the Institutional reporting procedures used on all residents of the Institution. Incident reports were filed by staff personnel whenever a behavior infraction occurred involving the resident; baseline and intervention data were then graphed from these incident reports. Baseline was graphed from the client's accumulated Institutional incident reports covering a prior period of one year that were presented to the investigators. The investigators were in contact with the client during intervention which lasted for a period of one year.

Before intervention began, a pilot study was conducted to determine whether the client was capable of keeping cards without losing them. In order to make this determination, he received a 3 x 5 index card with the time and day of the therapy sessions written on it. Not only was the client able to keep this card with him, but he began to present himself for his therapy sessions at the time and day written on the card. After a few weeks of pilot study, the use of cards for instruction and reinforcement purposes was deemed feasible.

Following the pilot study, treatment began. Intervention for the first baseline consisted of twice-weekly instructional sessions with the client. These meetings included discussion of previous incidents, as well as how to produce incompatible responses during times of peak aggression, e.g., when the client wanted to fight or swear. Initially, the client was asked to recall and discuss his feelings and behavior during periods of aggressive behavior. Because the client frequently demonstrated confusion regarding different behavior infractions, an Institutional staff member was invited to attend the therapy sessions to verify the accuracy of the client's recall. However, the investigators soon discovered that the client's confusion was an obstacle to therapy and the sessions then became instructional. During these meetings, the therapists would describe behaviors that were incompatible with fighting; instructions for these incompatible behaviors were: "don't fight"; "cool off"; and "walk away."

In addition to these vocal instructions, the client was given three cards with written instructions for proper behavior to be used during times of anger. Paralleling the vocal therapy sessions, the instructions on the cards were: 1) don't fight; 2) cool off; and 3) walk away. The client was instructed to carry the cards in his pocket and to read them when he felt angered and wanted to fight. At this point, staff members were informed of the procedure and instructed on the following: when the client appears agitated and is warning other clients and/or

staff that he will fight, staff members are to calmly tell the client to "look at your cards and do what they say." Verbal and written consequential stimuli were also used in this project. During each session, the client was verbally praised when there were no incidents of fighting (and later, swearing) during the interval between sessions. The client also carried a fourth card that recorded the number of days he had gone without a fight. At the beginning of each session, the number of days without fighting behavior was updated on the card. However, if an incident occurred, the card was exchanged for a blank one, and the number of recorded days without a fight began again.

After three months of proper behavior (no fighting), the investigators began intervention on the second baseline (swearing) in a similar manner. The client was given an additional card with the instructions "don't swear" to carry with the other behavior instruction cards. During this intervention phase, he also received another reinforcement card to monitor the number of days passed that he did not swear.

Because the client maintained residence in the dormitory and transitional housing throughout the therapy program, whatever consequence the Institution considered appropriate for the occurrence of unacceptable fighting behavior was recognized and followed. During times when the client was placed on restriction by Institutional personnel, therapy sessions were suspended until the restriction period was completed. During restriction, the client lost his spare time privileges and spent a 3-to-7 day interval in the restriction cottage.

In order to facilitate generalization, therapy sessions were held at different locations on the Institution's campus. A master list consisting of a variety of possible therapy locations was consulted before each session so that therapy locations were random and unpredictable. Included in this location list were areas such as: workshop; picnic area; home life setting; open office; and canteen. Therapy sessions were also held in the presence of various members of the Institution's staff, in addition to the regular therapist. By varying the therapy settings in this manner, staff members and therapists facilitated generalizations throughout the Institutional campus (Selzer-Azaroff and Mayer, 1977).

## RESULTS

Figure 1 represents data gathered prior to and after treatment and demonstrates the effectiveness of this program in reducing the number of fighting and swearing incidents. When viewing Figure 1, the reader should bear in mind that these were low frequency, high magnitude behaviors. The fighting was of such a magnitude that the client broke the thumb of the senior workshop supervisor. This was the precipitating event that caused the Institution to seek external help from the investigator.

Prior to intervention, fighting was controlled by 3 or 4 male attendants and/or supervisors restraining the client by holding him on the floor until he was subdued. The client would eventually tire and would

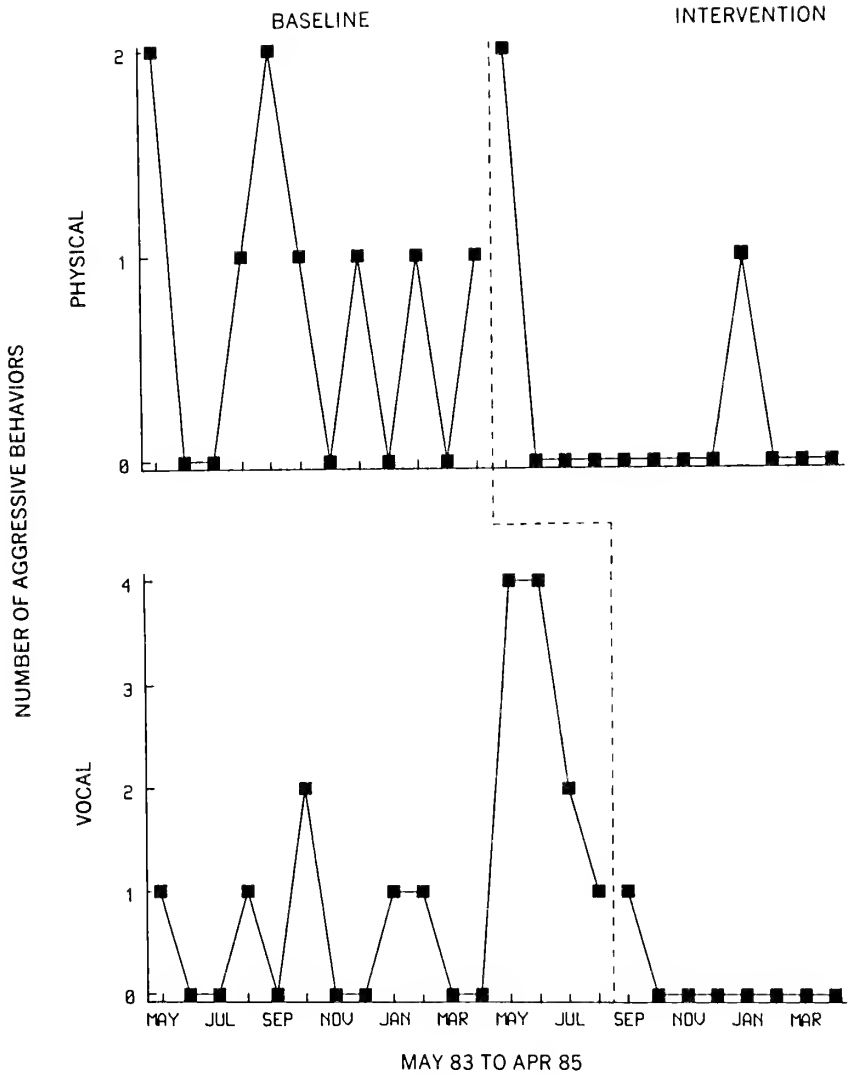


Figure 1. Multiple baseline design across two aggressive behaviors.

be escorted to his dormitory or a time-out room. Although the fighting occurred once or twice a month during baseline and was not a daily event, it was destructive enough to injure Institutional personnel and require a 3 to 4 person force to subdue him. Each act of fighting increased the probability of serious injury to the client or Institutional

personnel. During the baseline period for fighting behavior, the client had a total of 9 fighting incidents over 12 months for a mean of .75 incidents per month. The longest period during baseline between incidents was 2 months. After intervention, however, the client accumulated a total of 3 incidents in a 10-month period for a mean of .3 incidents per month. In addition, there was an interval of 7 months during which time no fighting occurred.

When the swearing data were analyzed, a similar pattern emerged. During the second baseline, the client recorded 17 incidents during a 16-month period for a mean of 1.06 incidents per month. The longest interval between swearing incidents was 2 months. After intervention for swearing behavior began, the client had only 1 incident in 6 months for a mean of .17 incidents per month.

Although the graph indicates a dramatic reduction in fighting and swearing behavior during intervention, the 3 fighting and 1 swearing incidents that occurred during intervention are noteworthy. Sixty-seven percent of the fighting and all of the swearing incidents occurred the first month. After the initial month of treatment, one fighting incident occurred after an 8-month interval, while no swearing incidents were recorded.

Because of the noticeable consistency of appropriate non-fighting behavior in later summer of 1984, the client was allowed to move into transitional housing to prepare for group home living. Transitional housing was a mobile home in a mobile home park located across the street from the Retardation Center. The client shared the two-bedroom facility with an older friend. Together they prepared meals, cleaned and maintained the trailer with minimal supervision.

### DISCUSSION

The data from this study indicate that the program has been effective in reducing the frequency of maladaptive physical and vocal aggressive behaviors. Although inappropriate behavior occurred during the treatment phase, the client demonstrated the behavior reducing effect of the visual antecedents.

In May, during the first month of therapy, two fighting opportunities arose. The first incident occurred when the client refused to return to his residential cottage and was physically removed to his cottage. Forced to return to his room, the client was angered, and he began to fight with the staff attendants. The second incident was a result of the restriction placed on the client for the first incident. When attendants came to escort the client to the restriction cottage, he resisted and began to fight them. It is noteworthy that at the time this second incident occurred, the client did not have his cards with him; they were in his jacket, which was left in his work area. The staff incident report stated that the client had asked for his cards, but the staff attendant was unable to obtain them before the fighting occurred.

The fight occurring 8 months later in January concerned a situation in which the client's supervisor prevented him from giving candy to a close friend, who was also a resident at the Institution. The client became very agitated and attempted to hit the supervisor who had stopped him from giving the candy to his friend. Although the client did not actually strike the supervisor, he became so agitated that he was taken to the time-out room, where he could regain control of his behavior.

Documentation of less severe incidents by the Institution revealed that there were instances when the client had the opportunity to fight but used his cards and did not fight. One such occasion occurred in June when a staff attendant found the client outside his work area during work hours. When the attendant attempted to escort him back to work, the client became very agitated. However, instead of fighting, the client referred to his cards and did not fight. Another similar situation involved an argument between the client and another resident. Instead of letting the argument lead to a fight, the client read his cards and stopped his aggressive behavior.

In addition to successfully reducing the client's fighting and swearing, this project demonstrated generalization of appropriate skills to the entire campus. Fighting and swearing were reduced in locations throughout the Institution's campus, as well as in the therapy settings. At times, when the client was allowed to attend off-campus functions, reduction of maladaptive behaviors was maintained.

Maintenance therapy sessions were held with the client by trained staff members from the Institution. A follow-up post check was conducted 3 months after the investigators left the project. The data indicated that there had been no fighting. An opportunity to fight arose 1 month after the investigators were gone but the client was told to "calm down," which he did, and a fight was avoided.

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LIFE CYCLE DURING A DROUGHT YEAR OF *CAECIDOTEA OBTUSUS*  
FROM A TEMPORARY POND IN NORTH ALABAMA  
(CRUSTACEA: ISOPODA)<sup>1</sup>

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ABSTRACT

The life cycle of the temporary pond isopod *Caecidotea obtusus* was examined in WEUP Pond, Alabama, during a drought year. This isopod inhabited the pond from the time the pond filled in winter until all standing water disappeared, a period of three months. It was able to produce eggs and leave offspring. However, because of the shortened life of the pond, the isopod experienced reduced fecundity. Evidence suggests that the young-of-the-year juveniles survive the dry phase of the pond by migrating through the sediments to subterranean ground water habitats that underlie the pond. These reemerge the following year, when the pond refills, to reproduce and die.

INTRODUCTION

Temporary ponds, because of their ephemeral nature, are severe habitats (Moore and Burn 1968; Moore 1970; Daborn and Clifford 1974; Belk and Cole 1975; Modlin 1980a). Climatic conditions strongly influence the temperature of the water. Atmospheric temperature, along with the magnitude of rainfall and evapotranspiration, determines the volume and longevity of water in the pond in a given year. The wax and wane of the level of water during a pond's life directly affects the content of dissolved oxygen, other dissolved chemical species, and suspended particles. Consequently, organisms that inhabit temporary ponds must be eurytopic to a wide variety of environmental conditions and, most importantly, be able to complete their life cycles in a relatively short period of time.

*Caecidotea obtusus*, a temporary pond isopod, is an annual resident in WEUP Pond. Individuals appear about two to three days after the pond fills and are present for the entire life of the pond (Bush 1983). The normal longevity of WEUP Pond is six months (Modlin 1982a, b). This study examines the life cycle of *C. obtusus* during a drought year when the pond it inhabited contained water for only about three months. Additionally, we attempted to determine the strategy that this isopod has evolved to survive during that part of the year when WEUP Pond is in its dry phase.

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*Description of the Study Area.* WEUP Pond (R1W T3S, section 21) is a depression in a stand of sweetgum trees, *Liquidambar styraciflua*, in the northwestern part of the city of Huntsville, Madison County, Alabama. Leaves of these trees canopy the depression from April to November and provide the 10 to 30 cm deep leaf-litter layer that covers the acidic, nutrient-rich Abernathy Silt Loam soil characteristic of the region. This soil has the ability to hold considerable amounts of moisture (Swenson, et al. 1958). Other ground cover vegetation is negligible. The depression receives water as runoff from adjacent agricultural fields and from subsurface seepage. In years with normal amounts of rainfall WEUP Pond fills in November and dries by mid-June. When filled to capacity the pond's areal extent is about 2600 m<sup>2</sup>. It has an average depth of about 0.2 m with a maximum depth of about 0.8m. The chemical composition of the water reflects that of the drainage basin (Modlin 1982a). Midday water temperature, measured on each sampling trip, ranged from 1.5° C in February to 21.5° C in March and April (Table 1). In addition to *C. obtusus* the pond contains an amphipod, *Crangonyx* sp., cladocerans (Modlin 1982b) and copepods, an oligochaete, and an occasional decapod. Periodically the faunal composition is enhanced by the anostracans *Eubbranchipus holmani* and *E. vernalis* (Modlin 1982a).

During the 1980-81 study period WEUP Pond did not begin to fill with water until late January, 1981. Water volume fluctuated considerably and never reached maximum. The pond contained most of its water during the first two weeks of April; surface area at this time was about 1800 m<sup>2</sup>. To relate the size of pond to isopod density and distribution, four arbitrary water levels were used to describe pond size and shape (Table 1). At level A the pond contained the least amount of water and consisted of unconnected puddles; at B the puddles were connected to each other; at C a solid expanse of water existed with its length greater than its width; and at D the length and width of the pond were nearly equal. WEUP Pond dried at the beginning of May 1981.

Table 1. Water temperature and abundance of *Caecidotea obtusus* (no./m<sup>2</sup>) observed in, and pond size (see text) of, WEUP Pond on each sampling trip during the 1980-81 period.

Sampling Date	Water Temperature	Pond Size	Isopod Abundance
1/30/81	6.0° C	A	889 / m <sup>2</sup>
2/06/81	1.5° C	D	132
2/14/81	2.8° C	D	178
2/25/81	16.0° C	D	311
3/10/81	16.0° C	C	355
3/17/81	18.5° C	B	311
3/26/81	21.5° C	B	289
4/02/81	21.5° C	D	156
4/16/81	18.0° C	D	178
4/28/81	21.0° C	A	267

## MATERIAL AND METHODS

Specimens of *Caecidotea obtusus* were collected with an 0.0225 m<sup>2</sup> Ekman Grab sampler at intervals of about seven to fourteen days from the time the pond filled to about four days before all standing water disappeared. A total of 19 samples were taken. Two samples were obtained, each from a different site, on each trip except the last. A single sample was collected on the last trip because of the scarcity of standing water. Samples were returned to the laboratory and fixed in 10% Formalin for three to four days before being sorted. Sorted specimens were preserved in 70% ethyl alcohol.

Water temperature in the pond was measured with a YSI Salinity-Conductivity-Temperature meter and a mercury thermometer on each sampling trip. These measurements were made at mid-depth and on the bottom at locations near the sites where isopod specimens were collected.

Total length of the specimens < 4.0 mm was measured to the nearest 0.1 mm along the dorsal midline from the anterior margin of the head to the posterior margin of the telson. Measurements of the small specimens were accomplished with a dissecting microscope equipped with an ocular scale. Specimens > 4.0 mm were measured to the nearest 0.5 mm with a plastic ruler attached to a measuring board. All isopods less than 3.5 mm were classified as juveniles because their sexual characteristics had not become apparent.

Eggs or larvae were counted to determine fecundity. These were scraped from the pouch with a metal probe before the count was made. Only those gravid females that contained full brood pouches were considered for this count.

Two different approaches were used to estimate the rate at which the isopods grew. The average total length of juveniles and adults was determined from individuals collected in the field on each sampling trip. Juveniles, males, and females were treated separately. These data were then plotted against the number of days elapsed since the first sample was collected (Modlin 1980b). In the second approach gravid females were brought into the laboratory, placed in an aquarium that was partially submerged in a recirculating constant temperature bath, and allowed to release their broods naturally. Then over the next 77 days, at irregular intervals, 10 to 20 juveniles were removed from the aquarium, measured for total length, and released back into the aquarium. Water temperature in the aquarium was maintained at a constant  $16 \pm 0.5^\circ \text{C}$ . Individual total lengths obtained during each sampling of the aquarium population were averaged. The average value was plotted against the number of days elapsed since the brood was released. In both approaches a least squares regression analysis was used to determine the rate of change in total length per day (Snedecor and Cochran 1967). During the latter approach the status of the gravid female after the release of her brood was noted.

Six 20 cm deep plug samples, about 0.0018m<sup>3</sup>, were taken from the pond's bottom in areas where standing water normally first appears to

determine if individuals of *C. obtusus* burrow into the sediments and become dormant during the pond's dry phase. These were collected in the 1981-82 season, four samples about four weeks and two more about two weeks, before WEUP Pond began to fall. Although standing water was not present, the soil was moist. These samples were returned to the laboratory and subjected to Tullgren funnel extraction (Merritt and Cummins 1978).

The ability of *C. obtusus* to withstand desiccation was tested by placing about 20 isopods in an aquarium containing leaf-litter from the pond covered by about 3 cm of pond water. Evaporation was allowed to take place at room temperature (22 to 25° C) until no standing water was visible. At this time the number of isopods surviving was determined.

## RESULTS AND DISCUSSION

Immature male and female specimens of *Caecidotea obtusus* were present about one week after standing water appeared in the WEUP Pond depression. They appeared to emerge in considerable numbers, 889/m<sup>2</sup> (Table 1). However, this large abundance resulted because emerging individuals were being concentrated in small puddles. Pond size on the first sampling trip was at level A. On subsequent sampling trips pond size increased, albeit with some fluctuation (Table 1). By March population size stabilized at about 315 individual/m<sup>2</sup>. Population size decreased during April when adults died off after reproducing. Females survived less than three weeks after releasing their broods. During April the population was composed of young-of-the-year juveniles (Fig. 1). Consequently, the longevity of *C. obtusus* was determined to be one year.

Adults collected on the first sampling trip, 30 January, averaged 5.9 mm in total length, range 4.5 to 7.5 mm. These grew to maturity in about 44 days. Gravid females were first collected on March 10th (Fig. 2). Gravid females ranged in size from 5.0 to 6.5 mm and carried an average of 47 eggs/female. Embryonic development of these eggs, determined according to Modlin (1982b) from the interval of time between the observance of the peak in numbers of gravid females (17 March) and the peak in the abundance of juveniles (16 April), was estimated to be 30 days. Juveniles, when released from the brood pouch, are 0.75 mm in total length. Juveniles collected on 16 April averaged 1.7 mm in total length and ranged from 1.5 mm to 3.5 mm (Fig. 2). Although sizes smaller than 1.5 mm were not observed, the estimate of developmental time appears to be acceptable because it compares well with that of related species living at similar water temperatures (Adcock 1979; Shuster 1981). Smaller sizes were probably overlooked when the samples were sorted. In the 28 April sample, about four days before all standing water disappeared, juvenile total length averaged 3.1 mm.

The total length of male *C. obtusus* increased 36% by the time they reached maturity, while the females only increased 8%. Male growth rate was estimated to be 0.06 mm/day by using the exponential relations  $Y = 5.73e^{0.008x}$ , where  $e$  is the natural logarithm,  $Y$  the estimate of total

length and X the number of days elapsed since the initial size was determined; this relationship had a correlation coefficient ( $r$ ) of 0.97 and was significantly different from zero ( $P < 0.001$ ). Females grew relatively little from the time they entered the pond until they matured. Because of the small increment of change and variability in

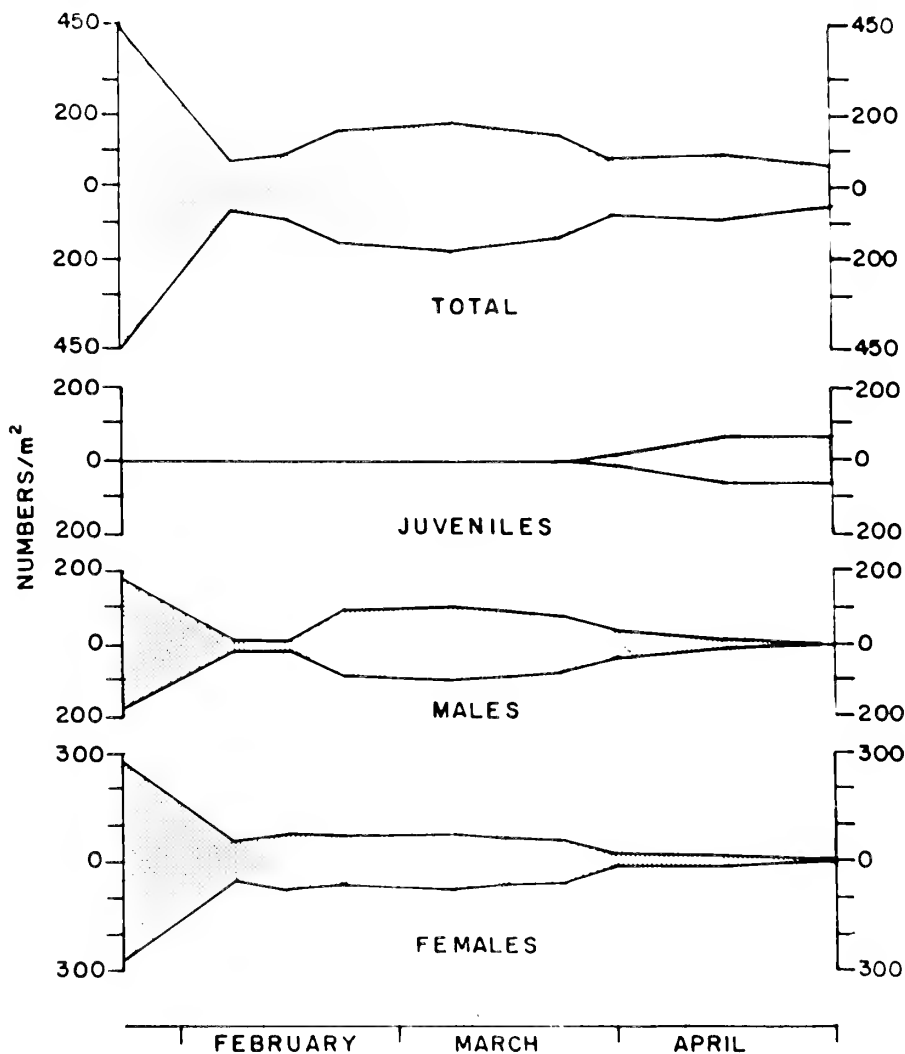


Figure 1. Abundance distribution of *Caecidotea obtusus* in WEUP Pond, Madison Co., AL during 1980-81.

Life cycle of *Caecidotea obtusus* during a drought year

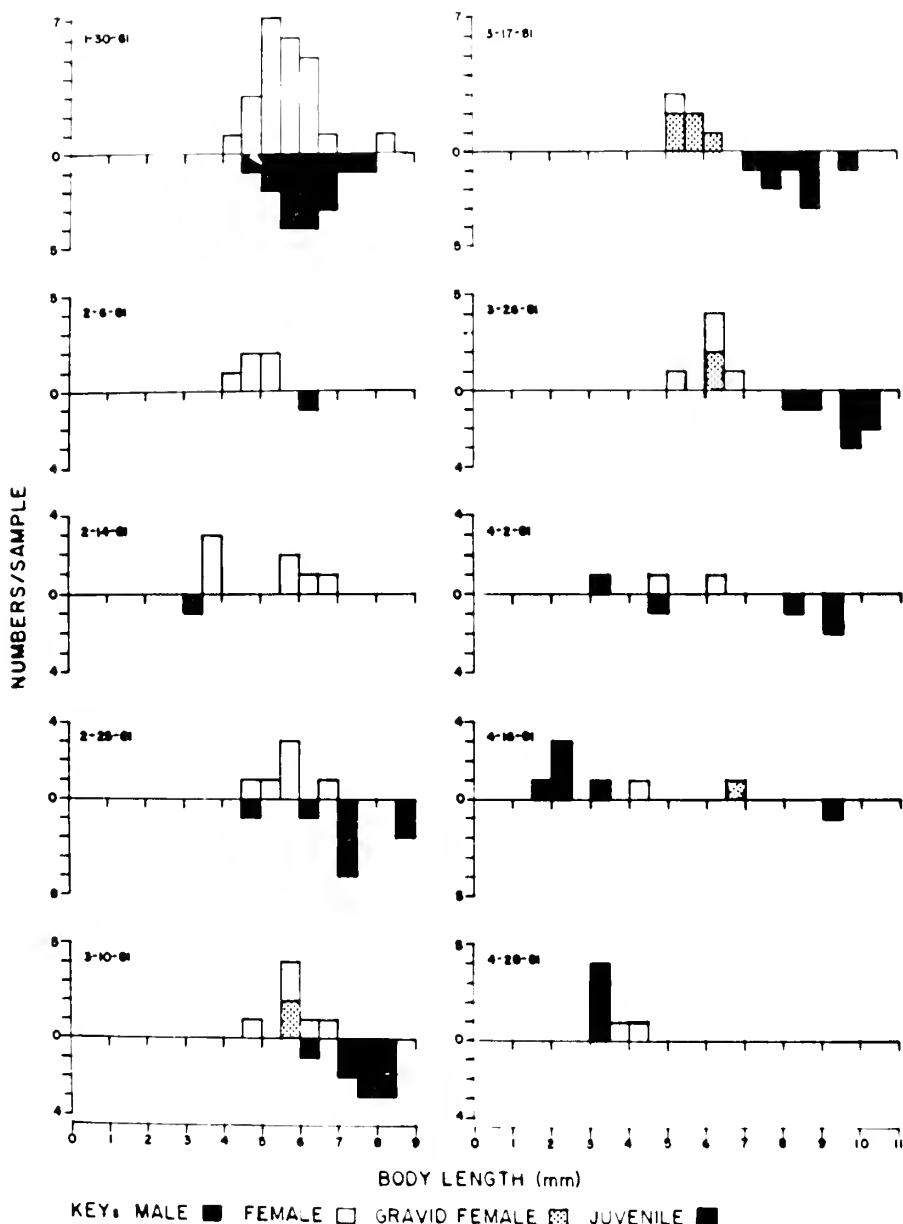


Figure 2. Length-frequency distribution of male, female, gravid female, and juvenile *Caecidotea obtusus* at WEUP Pond, Madison Co., AL during 1981-82. Male specimens are indicated by the black bars on the lower half of each histogram, juveniles by the black bars on the upper half, females by clear bars, and gravid females by stippled bars.

average total length of females between samples, a significant growth relationship could not be determined. Size related sexual dimorphism appears common along freshwater isopods (Styron 1968; Strong and Daborn 1980; Aston and Milner 1980; Shuster 1981).

The average daily increment of growth estimated from field data from the 1980-81 juvenile population was 0.12 mm/day. Because of the few samples, this growth rate was determined by taking the difference between the average total length of the juveniles on 16 April and 28 April divided by the number of days that had elapsed between the two sampling dates. In the laboratory growth of the juveniles followed the relationship,  $Y = 2.96e^{0.005X}$ , with  $r = 0.99$ . The daily increment of growth in the laboratory population was 0.02 mm/day. The extreme variation in growth rates between the field population and aquarium population was attributed to the temperature difference in the two habitats, a constant 16° C in the aquarium and an average of 19.0° C (range 16 to 21.5°) in WEUP Pond (Table 1). Growth in juvenile isopods is very sensitive to temperature and is retarded as temperature decreases (Sunderland et al. 1976; Adcock 1979). Strong and Daborn (1980) found that larger isopods are adversely affected by high temperatures, while juveniles grew very rapidly.

Three different strategies used by temporary pond isopods enable them to survive during the dry phase. 1. Moore and Burn (1968) found that *C. militaris*, which is synonymous with *C. intermedius* (Williams 1970), estivated in the substratum of the temporary pond; 2. Lewis and Bowman (1981) reported that Mackin and Hubricht (1940) observed *C. spatulata* to remain dormant in small mud cells it constructed; and 3. some temporary pond isopods were found to take refuge in crayfish burrows (Creaser 1931). Our evidence suggests that *C. obtusus* does not use either of the above strategies. Specimens of *C. obtusus* do not survive desiccation and none were extracted from soil samples collected toward the end of the pond's dry phase in 1981. In addition, crayfish burrows have never been observed in, or near, the study area.

As standing water disappears from WEUP Pond *C. obtusus* appears to enter the phreatic (subterranean) environment and reside in the ground water below the pond basin. To accomplish this the isopod must follow the water as it percolates through interstices formed along the root systems of trees. During the summer ground water occurs below the bedrock layer, which lies about 0.6 m below the surface of the soil. Only tree roots were able to reach the ground water by penetrating through the bedrock. Although hard evidence is not available, an observation and data on isopod growth provide intuitive support for the hypothesis that *C. obtusus* juveniles enter phreatic habitats to survive WEUP Pond's dry phase. Three days after WEUP Pond began to fill in the 1981-82 season, juvenile isopods collected near the bases of the sweetgum trees were not as heavily pigmented as those collected about one week later. When placed under laboratory lights, these almost white isopods darkened within 30 minutes. Since it is not known at this time if *C. obtusus* has fewer chromatophores or less total pigment than typical epigeal isopods, this observation is only circumstantial. However, if this species is phreatobitic and exposed to constant darkness during the pond's dry

phase, which was about 200 days, pigment within its chromatophores would contract (Kleinholz 1937; Waterman 1961; Lockwood 1967). Later, the pigment would expand when the isopod surfaced and was again exposed to daylight. Secondly, the fact that *C. obtusus* juvenile increased in length during the pond's dry phase does not support a strategy utilizing dormancy or estivation. Total length of the juveniles averaged 3.10 mm (range 1.5 to 3.5 mm) when standing water disappeared at the end of the 1980-81 study period. When they emerged during the 1981-82 season they averaged 5.24 mm, range = 4.5 to 7.4 mm. Utilizing the growth relationship determined for the laboratory population of juveniles, a total length of 8.04 mm was predicted from those that would emerge during the following season. A Student-t test did not indicate a significant difference between the actual and predicted lengths,  $p > 0.05$ . The discrepancy between the two averages can most likely be attributed to temperature (Sunderland et al. 1976; Adcock 1979). Soil temperatures, measured with a thermistor attached to the end of a metal probe that was pushed through the bottom sediments to the depth of the bedrock, were 12° to 13° C during the pond's dry phase, while the laboratory population of isopods were kept at a constant 16° C. The 3° to 4° lower temperature most likely suppressed the growth of the phreatic population.

The short fill season experienced in WEUP Pond in 1980-81 did not appear to adversely affect the population of *C. obtusus*. Individuals were able to complete their life cycle within the three month period. However, the population may have suffered a reduced fecundity level. WEUP pond began filling in December 1981-82 and females collected near the end of January 1982 were larger than those collected at the same time in the previous season. The 1982 females at this time had experienced about 40 additional days of growth in the surface habitat; these averaged 7.6 mm in total length and were already larger than the largest females collected in 1981 (Fig. 2). Although the number of eggs carried by the 1982 female population was not determined, in the Isopoda egg numbers are directly correlated to a female's size (Chambers 1976). Males were also larger in 1982; they averaged 11.4 mm.

#### ACKNOWLEDGMENTS

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SOME EXTREMUM PRINCIPLES IN PARABOLIC EQUATIONS<sup>1</sup>

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ABSTRACT

In this note several maximum and minimum principles are developed for the functionals defined on the solutions of various boundary-value problems for semilinear parabolic equations in one space dimension. This leads to estimates on the growth of solutions and on solution values. These results are further extended to  $n \geq 2$  space dimensions.

1. Extremum Principles

Let  $E$  denote the region

$E: \{(x,t): 0 < x < l, 0 < t < T\}$  and suppose

$S = S_1 \cup S_2 \cup S_3$  where

$S_1 = \{(0,t): 0 < t < T\}$ ,  $S_2 = \{(x,0): 0 \leq x \leq l\}$  and

$S_3 = \{(l,t): 0 < t < T\}$ .

Lemma: Suppose  $u(x,t) \in C^3(E) \cap C^1(E \cup S)$  satisfies the semilinear equation

$$a(x)u_{xx} + b(x)u_x + q(x)f(u) - u_t = 0 \quad (1)$$

then the functional

$$W(x,t) = - \frac{u_t^2}{p(x)} + 2 \int_0^u f(v)dv \quad (2)$$

attains its minimum on  $S$  provided

(i)  $a(x) > 0$ ,  $b(x) \geq 0$  and  $q(x) \geq 0$

(ii)  $p(x) > 0$ ,  $p'(x) \leq 0$  and  $p''(x) \leq 0$

and (iii)  $f'(u) \leq 0$

and maximum on  $S$  if

(i)'  $a(x) > 0$ ,  $b(x) \geq 0$ ,  $q(x) \leq 0$

(ii)'  $p(x) < 0$ ,  $p'(x) \geq 0$ ,  $p''(x) > 0$

and (iii)'  $f''(u) \geq 0$ .

<sup>1</sup>Manuscript received 10 July 1987; accepted 30 March 1988.

Proof: We compute

$$W_x = \frac{-2u_t u_{tx}}{p} + \frac{u_t^2 p'}{p^2} + 2f(u)u_x \quad (3)$$

$$W_{xx} = \frac{-2u_{tx}^2}{p} - \frac{2u_t u_{txx}}{p} + \frac{4p' u_t u_{tx}}{p^2} + \frac{u_t^2 p''}{p^2(x)} - \frac{2u_t^2 p'^2}{p^3} + 2f'(u)u_x^2 + 2fu_{xx}$$

$$W_t = \frac{-2u_t u_{tt}}{p} + 2f(u)u_t.$$

Since

$$a(x)W_{xx} = \frac{-2a(x)(pu_{tx} - p'u_t)^2}{p^3(x)} - \frac{2u_t u_{txx} a(x)}{p(x)} + \frac{u_t^2 p''(x)a(x)}{p^2(x)} + 2a(x)f'u_x^2 + 2fa(x)u_{xx}$$

and from equation (1)

$$\frac{-2a(x)u_t u_{xxt}}{p(x)} = \frac{-2u_t}{p(x)} [u_{tt} - q(x)f'(u)u_t - b(x)u_{tx}]$$

it follows that

$$\begin{aligned} a(x)W_{xx} + b(x)W_x - W_t &= \frac{-2a(x)}{p^3} (pu_{tx} - p'u_t)^2 + \frac{2f'}{p(x)} [q(x)u_t^2 + p(x)a(x)u_x^2] \\ &+ \frac{u_t^2}{p^2} (p''a(x) + p'b(x)) - 2q(x)f^2(u) \end{aligned}$$

Now since  $f' \leq 0$ ,  $W$  attains its minimum on  $S$  because of (i) and (ii). On the other hand, it is clear that in view of (i)', (ii)' and (iii)'  $W$  attains its maximum on  $S$ .

As an application of the Lemma we derive the following

Theorem 1. Assume that the conditions (i), (ii) and (iii) of the lemma hold and let  $u \in C^3(E) \cap C^1(E \cup S)$  be a solution of (1) in  $E \cup S_2$  such that

$$u(0, t) = 0 = u(l, t), \quad u(x, 0) = g(x). \quad (4)$$

Then  $W$  attains its minimum on  $S_2$ . Also if  $W(x, 0) \geq 0$ , then

$$u_t^2 \leq 2p(x) \int_0^u f(v)dv \quad \text{in } E \cup S \quad (5)$$

and if  $W(x, 0) < 0$  for some  $x \in S_2$ , then there is an  $x_2 \in S_2$  where

$$W(x_2, 0) = \min_{S_2} W(x, 0)$$

for which

$$\frac{u_t^2}{p(x)} \leq \frac{\{a(x_2)g''(x_2) + q(x_2)f(g(x_2)) + b(x_2)g'(x_2)\}^2}{(px_2)} + 2 \int_{g(x_2)}^u f(v)dv \quad (6)$$

in  $E \cup S$ .

Proof: Because of the conditions of (4), it follows that

$$W(0, t) = W(l, t) = 0.$$

Using equation (1), we get

$$\begin{aligned} W(x, 0) &= \frac{-[u_t(x, 0)]^2}{p(x)} + 2 \int_0^u f(v)dv \\ &= \frac{-(a(x)g''(x) + b(x)g'(x) + q(x)f(g(x)))^2}{p(x)} + 2 \int_0^{g(x)} f(v)dv. \end{aligned}$$

Now because of the Lemma and the supposition  $W(x, 0) \geq 0$ , we conclude that  $W(x, t) \geq 0$  in  $E \cup S$ , i.e.

$$u_t^2 \leq 2p(x) \int_0^u f(v)dv.$$

If, however,  $W(x, 0) < 0$  for some  $x \in S_2$  then with the help of the lemma it is easy to deduce that

$$W(x, t) \geq W(x_2, 0)$$

since  $W$  attains its negative minimum at  $(x_2, 0)$  for some  $x_2 \in S_2$ . This implies

$$\frac{u_t^2}{p(x)} \leq \frac{\{a(x_2)g''(x_2) + b(x_2)g'(x_2) + q(x_2)f(g(x_2))\}^2}{p(x_2)} + 2 \int_{g(x_2)}^u f(v)dv$$

in  $E \cup S$ , which completes the proof of (6).

Remark: If  $b(x) = 0$  and  $q(x) = 1$ , then clearly the estimates (5) and (6) are sharper than the corresponding estimates (2.5) and (2.6) respectively of Chan and Schaefer [1]. Since in this special case the hypotheses on  $p$  would be

$$p > 0, p' \leq 0 \text{ and } p'' \leq 0$$

which are satisfied by any positive constant less than 1.

Theorem 2: If  $u \in C^3(E) \cap C^2(E \cup S)$  is a solution of (1) in  $E \cup S_2$  such that

$$u_x(0,t) = 0 = u_x(l,t), u(x,0) = g(x) \quad (7)$$

then

$$W(x,t) = \frac{-u_t^2}{p(x)} + 2 \int_0^u f(v) dv$$

attains its minimum on  $S_2$  and there is an  $x_3 \in S_2$  where

$$W(x_3,0) = \min_{S_2} W(x,0)$$

such that

$$\frac{u_t^2}{p(x)} \leq \frac{\{a(x_3)g''(x_3) + b(x_3)g'(x_3) + q(x_3)f(g(x_3))\}^2}{p(x^3)} + 2 \int_{g(x_3)}^u f(v) dv \quad (8)$$

in  $E \cup S$ , provided

$$P'(0) = 0 = P'(l). \quad (9)$$

Proof: Conditions (7) and (9) applied to (3) give

$$W_x(0,t) = W_x(l,t) = 0.$$

Consequently by the lemma above and Hopf's lemma [2, page 170],  $W$  attains its minimum on  $t = 0$  say at  $(x_3,0)$ . Hence

$$W(x,t) \geq W(x_3,0)$$

in  $E \cup S$ . Hence the proof of (8) is complete.

Remark: Again, if  $(b(x) = 0, q(x) = 1, \text{ equation (2.1) [1] becomes a particular case of (1). Then the estimate (8) is sharper than (2.8) of [1] since } p(x) \text{ could be chosen a positive constant less than 1.}$

As an application of the above estimates we consider the following problem of one dimensional electron concentration  $u$  in a decaying plasma studied by Chan and Schaefer [1]

$$a(x)u_{xx} - bu^2 - u_t = 0 \quad (b \text{ is a positive constant})$$

$$u_x(0,t) = 0 = u_x(l,t), \quad t > 0$$

$$u(x,0) = c \quad 0 \leq x \leq l$$

where  $c$  is a positive constant.

In this case

$$W(x,0) = \frac{-(-bc)^2}{p(x)} + 2 \int_0^c (-bv^2)dv = -bc^3 \left[ \frac{bc}{p(x)} + \frac{2}{3} \right] < 0.$$

Hence we have

$$\frac{u_t^2}{p(x)} \leq bc^3 \left[ \frac{bc}{p(x_0)} + \frac{2}{3} \right] + 2 \int_0^u (-bv^2)dv.$$

If we choose  $p(x)$  to be a positive constant  $m < 1$ , then

$$u_t^2 \leq bc^3 \left[ bc + \frac{2m}{3} \right] - \frac{2bmu^3}{3}.$$

Since the forcing term acts like a sink,  $u \leq c$  and that as  $t \rightarrow \infty$ , the solution  $u \rightarrow 0$ . If we let  $T(\epsilon)$  be the time for which

$$|u(x,t)| \leq \epsilon \text{ for all } t \geq T(\epsilon),$$

we have

$$|u_t| \leq \{bc^3(bc + \frac{2m}{3})\}^{1/2}$$

$$\text{or } \int_{\epsilon}^c du \leq \{bc^3(bc + \frac{2m}{3})\}^{1/2} \int_0^{T(\epsilon)} dt$$

or,

$$T(\epsilon) \geq (c - \epsilon) \{bc^3(bc + \frac{2m}{3})\}^{-1/2} \quad (10)$$

which gives a lower bound on time to  $\epsilon$ -approximation of uniform state. Also for

$$0 \leq t \leq c \{bc^3(bc + \frac{2m}{3})\}^{1/2},$$

we have

$$u_t \geq - \{bc^3(bc + \frac{2m}{3})\}^{1/2}$$

from which we conclude that

$$u(x,t) \geq c - \{bc^3(bc + \frac{2m}{3})\}^{1/2} t \quad (11)$$

Remark: The estimates (10) and (11) are sharper than the corresponding estimates of Chan and Schaefer [1].

2. Additional Extremum Principle

In this section we consider a functional different from that of the last section and defined on the solutions of

$$u_{xx} + p(x)f(u) - u_t = 0 \quad (12)$$

and obtain extremum principle under less restriction on the nonlinearity of  $f$ . Thus, we have,

Theorem 3: If  $u \in C^2(E) \cap C^1(E \cup S)$  is a solution of (12) then

$$Y(x, t) = \frac{u_x^2}{p(x)} + 2 \int_0^u f(v) dv \quad (13)$$

attains its maximum or minimum either on  $S$  or at a point in  $E$  where  $u_x = 0$  according as

$$p'^2 - 2pp'' \quad (14)$$

is positive or negative respectively and provided  $f$  is continuous in  $E$ .

Proof: We compute

$$\begin{aligned} Y_x &= \frac{2u_x u_{xx}}{p} - \frac{p' u_x^2}{p^2} + 2f(u) u_x \\ Y_{xx} &= \frac{-2p'}{p} Y_x - 2u_t f(u) + \frac{2u_t^2}{p} + \frac{2u_x u_{xt}}{p} + \frac{2u_x p' f(u)}{p} - \frac{p'' u_x^2}{p^2} \\ Y_t &= \frac{2u_x u_{xt}}{p} + 2f(u) u_t. \end{aligned}$$

Now with the help of (12) and (13) we deduce that  $Y$  satisfies

$$Y_{xx} - Y_t = \frac{Y_x}{2pu_x^2} (p^2 Y_x - 2(p' u_x^2 + 2f(u)p^2 u_x)) + \frac{u_x^2}{2p^3} (p'^2 - 2pp'')$$

that is,

$$Y_{xx} + \frac{Y_x}{2pu_x^2} (2(p' u_x^2 + 2f(u)p^2) - p^2 Y_x) - Y_t = \frac{u_x^2}{2p^3} (p'^2 - 2pp'')$$

clearly, because of (14) we have the desired result.

Remark: 1. This theorem generalizes Lemma 2 [1].

2. Using the functional (13), theorem 2 can be extended to the case of the more general equation:



$$u_{xx} + b(x)u_x + p(x)f(u) - u_t = 0.$$

with suitable assumptions on  $b(x)$ ,  $p(x)$  and  $f$ .

### 3. Extension to the case of $(n \geq 2)$ - dimensions

In this section we shall use comma notation for partial differentiation and summation convention on repeated indices, i.e.  $U_{,ii}$  is the  $n$ -dimensional Laplacian of  $U$ .

Theorem 4: Let  $U$  be a sufficiently smooth solution of

$$U_{,ii} + p(x)f(U) - U_t = 0 \text{ in } D \times (0, T)$$

where  $D$  is a bounded domain in Euclidean  $n$ -space. Then the functional

$$Z(x, t) = \frac{1}{p} U_t^2 + 2 \int_0^U f(v) dv$$

attains its minimum on the "parabolic" boundary  $\partial D \times (0, T)$  or  $\bar{D} \times \{0\}$  if

$$f' \leq 0, p > 0, p_{,ii} \leq 0.$$

Proof: We compute

$$Z_{,i} = -\frac{2U_{,t}U_{,ti}}{p} + \frac{U_{,t}^2 p_{,i}}{p^2} + 2f(u)U_{,i}$$

$$Z_{,ii} = \frac{-2U_{,ti}U_{,t}}{p} - \frac{2U_{,t}U_{,tii}}{p} + \frac{4U_{,t}U_{,ti}p_{,i}}{p^2} + \frac{U_{,t}^2 p_{,ii}}{p^2} - \frac{2u_{,t}^2 p_{,i}^2}{p^3}$$

$$Z_{,t} = \frac{-2U_{,t}U_{,tt}}{p} + 2f(u)U_{,t}.$$

Thus,

$$\begin{aligned} Z_{,ii} - Z_{,t} &= 2f'[U_{,t}^2 + U_{,i}U_{,i}] - 2pf^2 + \frac{U_{,t}^2 p_{,ii}}{p^2} \\ &\quad - \frac{2}{p^3}[p^2 U_{,ti}U_{,t} - 2pU_{,ti}p_{,i}U_{,t} + U_{,t}^2 p_{,i}^2] \end{aligned}$$

So if  $f' \leq 0$ ,  $p > 0$  and  $p_{,ii} \leq 0$  then  $Z$  attains its minimum on the boundary, which completes the proof of theorem 3.

If  $U = 0$  on  $\partial D \times (0, T)$ , then it follows that  $U_{,t} = 0$  and hence  $Z = 0$  on  $\partial D \times (0, T)$ . Thus the estimates of the form (5) and (6) in [1] can be obtained.

Remark: Theorem 4 extends the results in Section 4 of [1].

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A NOTE ON LIOUVILLE THEOREM FOR HARMONIC FUNCTIONS  
IN THE N-DIMENSIONAL SPACE<sup>1</sup>

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In [1] the Liouville theorem for harmonic functions has been proved in two forms -- strong form and weak form. The strong form of the Liouville theorem, derived by means of Harnack inequalities, states that every harmonic function bounded either above or below in the whole of  $n$ -space  $E_n$  is constant. The weak form of the Liouville theorem, which one concludes via the mean-value theorem, is that a harmonic function bounded both above and below for all  $x = (x_1, x_2, \dots, x_n)$  is constant.

The purpose of this note is to show how a simple inequality given by Nehari [2] can be used to obtain the weak form of Liouville theorem.

First we prove the following lemma.

Lemma: Let  $u = u(x_1, x_2, \dots, x_n)$  be a harmonic function, i.e.

$$\Delta u = 0 \quad (\Delta = \frac{\partial^2}{\partial x_1^2} + \frac{\partial^2}{\partial x_2^2} + \dots + \frac{\partial^2}{\partial x_n^2}).$$

Suppose  $u$  has three continuous derivatives for

$r < R$  ( $r^2 = x_1^2 + x_2^2 + \dots + x_n^2$ ,  $r \geq 0$ ). Then

$$\alpha(x) = |\text{grad } u|^2 \quad (1)$$

is subharmonic. Further,

$$\beta(x) = u^2(x) \quad (2)$$

is such that

$$\Delta \beta(x) = 2\alpha(x) \quad (3)$$

Proof: To prove that  $\alpha(x)$  is subharmonic we use the comma notation for partial differentiation and compute

$$\Delta \alpha(x) = 2 \sum_{k=1}^n \sum_{m=1}^n u_{,mk} u_{,mk} + 2(\text{grad } u, \text{grad } \Delta u). \quad (4)$$

<sup>1</sup>Manuscript submitted 10 July 1987; accepted 30 August 1988.

In view of the well-known inequality

$$\sum_{k=1}^n \sum_{m=1}^n u^2, \quad mk \leq \frac{(\Delta u)^2}{n}$$

(4) becomes

$$\Delta \alpha(x) \leq \frac{2}{n} (\Delta u)^2 + 2 (\text{grad } u, \text{grad } \Delta u).$$

But, since  $u(x)$  is harmonic, we conclude that  $\Delta \alpha(x) \geq 0$  and hence  $\alpha(x)$  is subharmonic.

Now differentiate  $\beta(x)$  partially two times with respect to  $x_m$  and sum over  $m$ . Since  $u(x)$  is harmonic,

$$\Delta \beta(x) = 2 \left| \text{grad } u \right|^2 = 2\alpha(x).$$

This completes the proof of the lemma.

Now we are ready to prove the Liouville theorem:

**Theorem:** If  $u$  is a harmonic function which is bounded in all of  $n$ -space  $E_n$ , then  $u \equiv \text{constant}$ .

**Proof:** Since  $\alpha(x)$  is a non-negative subharmonic function in  $E_n$ , we use (3) and a Green Identity to deduce

$$0 \leq \alpha(x) \leq \frac{1}{|D|} \int_D \alpha(y) dy \leq \frac{1}{2|D|} \int_D \Delta \beta(y) dy = \frac{1}{2|D|} \int_{\partial D} \frac{\partial}{\partial \nu} \beta(y) ds \quad (5)$$

where  $D$  is a Green domain in  $E_n$ ,  $|D|$  denotes the volume of  $D$ ,  $\frac{\partial}{\partial \nu}$  is the outward normal derivative operator. Now let  $D$  be the ball  $B_r$  of radius  $r$  with center at  $x$  (fixed but arbitrary), volume  $v_r$  and surface area  $s_r$ .

The inequality (5) then becomes

$$0 \leq \alpha(x) \leq \frac{1}{2v_r} \int_{\partial B_r} \frac{\partial}{\partial r} u^2 ds_r.$$

Now since  $s_r = r^{n-1} s_1$  and  $v_r = r^n s_1$ , we can write

$$0 \leq 2r\alpha(x) \leq \frac{n}{s_1} \frac{\partial}{\partial r} \int_{\partial B_1} u^2 ds_1.$$

Integrating with respect to  $r$  from 0 to  $R$ , we obtain

$$0 \leq \alpha(x) \leq \frac{n}{s_1 R^2} \int_{\partial B_1} u^2(R) ds_1 \quad \frac{n}{R^2} u^2(x)$$

where  $u^2(R)$  has the obvious meaning.

Now from (1) and the boundedness of  $u$ , we see that

$$\alpha(x) = |\text{grad } u(x)|^2 \rightarrow 0 \text{ as } R \rightarrow \infty$$

and consequently  $u(x) \equiv \text{constant}$  in  $E_n$ .

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ABSTRACT

FORESTRY, GEOGRAPHY, CONSERVATION AND PLANNING

PROBLEM RESOLUTION THROUGH AREA WIDE LABOR-MANAGEMENT COMMITTEES. Rick Lester, Assistant Professor of Management, and Gerald Crawford, Professor of Marketing, University of North Alabama, Florence, AL 35632.

It is apparent that many of the activities between management and labor unions assume an adversarial role; however, there are situations in which the position of cooperation, of integrative bargaining, would produce mutually advantageous outcomes. One more recent approach is the Area Wide Labor Management Committee (AWLMC).

A sample of 510 subjects (union and non-union) were surveyed to determine, within the Quad-City, Alabama area, the labor problem areas and the perceived appropriateness of an AWLMC in their correction.

The results clearly point to the fact that the respondents saw major labor problems; however, these issues were seen as short-term. As a whole, labor unions were given the greatest share of blame for these problems even in areas out of the unions' control. Finally, the respondents agreed that constructive efforts had to be made to correct these problems and an AWLMC was seen as a viable option.

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